THE

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ELECTRICAL REVIEW.

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THE GREENWICH BOILER EXPLOSION INQUIRY.

WHAT the result of this Board of Trade inquiry will be cannot at the moment of writing be foreseen. To the looker-on the affair appears to have resolved itself into a kind of duel between the steel makers and the boiler makers, the former contending that the plate was injured by the curious indentations put into it round the flanging by the snap of the riveter when closing the plates before riveting, while the latter assert that the plate was brittle. The evidence of the Board of Trade inspector who tested the parts of the head that failed, seemed to show that the plate was initially damaged by the indenting, and that even fine cracks—shear cracks, as they may be called—were actually started, and ultimately so extended themselves under the breathing of the plate as to lead to the rupture. But the boiler makers appeared to hold that had the plate been as ductile as it ought to have been, these slight indentations would not have made any difference to the safety of the plate. Mr. Ferney, the inspector of new work for the boiler makers, was of opinion that the indentations were of no moment. They were $\frac{1}{8}$-in. deep, he estimated, and he would have drawn attention to them had they been $\frac{3}{16}$ in. At this point of the inquiry the folly of the attempts of "learned counsel" to get what *they* thought was the truth out of this witness became painfully obvious to onlookers. Evidently they imagined that he was trying to cover up something, and the painful spectacle was presented of a practical inspector of work doing his best to state facts, and putting his answers in such a way that every engineer in the room understood him perfectly, while all the time counsel seemed to be striving after an answer to fit their own curious legal attitude of mind. It was as though they would demand from an engineer an oath that his three-and-sixpenny 2-ft. rule was exactly 2 ft. in length, and would wish to commit him to the Tower for not swearing exactly to its perfect accuracy. It would seem that inquiries into technical matters call for some different method of procedure. Boiler inspectors are not set to ask questions of witnesses in international arbitrations, yet they are fully as qualified for this work as are legal men for engineering inquiries.

Without saying that Mr. Ferney was right in his estimate of the indentations, it is certain that he tried to give truthful answers, though counsel appeared unable to realise the fact.

Now, brittle or not brittle, this plate which failed was not bad material. There was a minute inquiry into the plate and into the indentations, but not a word reached us about the question of stays.

Had the drum been properly fitted with a longitudinal stay bolt of proper strength, this failure would not have occurred in the form of a serious explosion. Even had the plate failed, it would not have been likely to cause damage; the drum would have blown empty. More probably the crack would have leaked so badly that the boiler with its storage vessel would have been laid off. We cannot understand why the unstayed drum was insured by the Boiler Insurance Co. It is certain that boiler experts generally would object to such an omission. These modern thermal drums are not egg-ended; they have ends only slightly dished, and exposed to very considerable concertina action with every variation in pressure, and ultimate failure must inevitably occur, so that through staying is important.

Electrical Trade with Canada.

THOSE who take the trouble to wade through the 117 quarto pages of the Blue Book which has just been issued on the conditions and prospects of British trade in Canada will, perhaps, be surprised at the insignificant attention paid to the electrical engineering industry, if not at the antiquated information which it contains from a statistical point of view. We mention the latter point, because in the concluding pages of the Blue Book which was issued in the third week of January, appear the titles of the Canadian Government publications, and among these is given the monthly statement of imports and exports. If, then, the returns are issued monthly, it should surely be possible in January, 1908, to give the figures for the financial year which ended on June 30th, 1907. Nevertheless, the statistics must be accepted as they are set forth in the official report. We are told, in the first place, that the development of electrical energy from water power, and its transmission, represent a matter of the utmost importance in Canada, both because coal for steam raising is dear at $4 per ton in Ontario—what about England at 16s. per ton at the present time?—and because of the numerous waterfalls available for the production of power. This statement is illustrated by reference to Niagara Falls, and we next pass to the well-known statement that the only serious competition with the United Kingdom comes from the United States. If we look at the table of imports into Canada in the year ended June 30th, 1906, we find the United States credited with a value of $3,461,000 for electrical apparatus, but not a cent is attributed to the United Kingdom in the same year. We get, however, on a slightly more solid foundation when consideration is given to Canadian manufactures and to one of the appendices to the Blue Book. As far as the former is concerned, it appears from the industrial census of 1906 that Canadian firms produced electrical apparatus to the value of $1,380,000 in round figures in 1900, as compared with $2,893,000 in 1906, whilst electric light and power, however it may have been valued, is recorded as $3,052,000 and $8,996,000 respectively. Passing along we observe the following statement of imports in 1902 and 1906 :—

IMPORTS OF ELECTRICAL APPARATUS AND SUPPLIES.

From—	1902.	1906.
United Kingdom ...	15,745 dollars	81,412 dollars
United States	1,350,505 „	3,461,000 „

But better times are in store for British exporters, according to Mr. John Bain, formerly deputy commissioner of Canadian Customs. He asks who is to blame for the preponderancy of the United States. Surely not, he states, the Canadian Government, who have provided in the tariff that such British-made apparatus only pays 15 per cent. *ad valorem*, as against 27½ per cent. charged on United States productions. Britain, he declares, is not behind the age in electrical development, but she is very much behind in the Canadian market. Mr. Bain, however, overlooks the fact that it requires a great deal to counteract the geographical advantage of the United States, and that the United States foundations in Canada naturally control a large portion of the market, as, for instance, the Canadian Westinghouse Co. and the Canadian General Electric Co. The only thing for British firms to do is to endeavour by individual enterprise to promote trade with Canada, and to do so by means of principals, and not by agents who are unable to decide matters on the spot. Some comments on this point, made by Sir W. Van Horne, chairman of the Canadian Pacific Railway, appeared on page 753 of our issue of May 11th, 1906 We have on several occasions* tried to impress upon the British electrical industry the importance of giving better attention to the requirements of the Canadian market. It might, perhaps, pay if we made fewer complainings concerning home trade, and laid ourselves less open to the charge of neglecting our Colonial market opportunities, where it seems that now, if ever, it is necessary to put in the foundations for a big future business.

* See ELECTRICAL REVIEW December 30th, 1904; February 10th and 17th, 1905; October 20th, 1905.

The Tube Railways of London.

A MILD sort of scare has been caused by several tube railway passengers writing letters to the newspapers concerning their own ideas of the potential dangers on the underground electric railways of London. What led to the correspondence seems to have been a small affair that occurred on January 8th. The Board of Trade officials, Major J. W. Pringle and Mr. A. P. Trotter, are to be congratulated upon the promptitude with which they, on January 17th, circulated their report on the matter, showing, among other things, how groundless were the fears, and how unnecessary were the epistles, of these correspondents. The statements contained in the report (see page 128), if read *in extenso* by the public—as they ought to be—should restore the confidence of the travelling public if the scare correspondence has shaken it. The public has a short memory, for it appears to have forgotten that, both before and after the accidents of Paris and Liverpool, the fullest attention was given to the London tube arrangements, with a view to securing immunity from such disasters. A reference to Parliamentary and other reports published in our own pages, particularly in January, March and April of 1902, will show how closely the matter was followed by Col. Yorke and his department.

We observe that in a railway contemporary it is suggested that at all stations on the tube railways there should be posted up information concerning the precautions taken in order to ensure safety. This would be tantamount to telling the public that dangers lurk in these tube systems. To educate the travelling public in such a matter is undoubtedly important, but to be constantly reminding them, in "every car" and "at every station," seems to us to show an excess of zeal.

We are not sure that such a course would not do more harm than good. While the effect on the minds of a few might be satisfactory, it might, and we think would, for the majority aggravate the evil of present nervousness, and promote just that kind of spirit which would make a really good panic when a short-circuit and smoky event practically free from danger occurred. The tube railways have had financial tribulations which are quite undeserved considering the great service that they have rendered in ameliorating the traffic congestion of the Metropolis. As their great convenience becomes better known by the public, no doubt they will be better patronised. Their record is a clean one from the accident point of view, and anything likely to create suspicion or prejudice would require most careful consideration before adoption.

There may be an element of humour present when we are told that the sailor feels safer on his ship than he does in town, but it is a plain fact that tube passengers may feel quite as safe, or safer, while in the tube than when passing along the surface thoroughfares with their erratic and smelly motor-'buses.

Electrical Vehicles in Berlin.

IT is stated in the course of an article published by a Berlin newspaper on the subject of electrical vehicles, that as sporting enthusiasm in automobiles is beginning to slacken in that country, motor-cars for useful purposes are coming into the foreground, whilst at the same time the construction of electromobiles has been begun on a large scale. This statement is explained by the announcement that the Allgemeine Electricity Co., the Siemens-Schuckert Works Co., the Bergmann Co., the Mercedes Co., and the North-German Lloyd Engineering Co., have embarked upon the manufacture of electrical vehicles; and the lack of a supply of competent workmen, who have had years of experience in the production of benzine motor-cars, has now been overcome. As a result of an inspection of the electrical vehicles at the recent Automobile Exhibition in Berlin, it is stated that makers are going too far in the copying of the external shape of the petrol

motor-car for that of the electrical vehicle, just as if the owners were ashamed of using electricity as the motive power. As to the methods of driving, there were to be found gear for front-wheel driving, rear-wheel action and both single motors and the two-motor system, whilst the building-in of the motor in the wheels is gaining more advocates. The newspaper proceeds to suggest that commercial electrical vehicles are destined to play a leading part in city traffic, particularly those capable of transporting a load of 2 tons, as well as delivery and advertisement wagons, hotel omnibuses, street washing machines and other classes of vehicles.

Cylinder Leakage v. Condensation.

For some time past a school of theorists, who make up by advertisement for their paucity of numbers, has been endeavouring to upset the practical theory of the steam engine as established by D. K. Clark, Hirn, and others, and to put in its place a very unsufficing theory of leakage. We were pleased to see in the *Engineer* last month some excellent criticism of the valve leakage theory, which, as our contemporary remarks, has "just three" patrons. The conclusion is drawn that the theory is based on evidence much too slight and too narrow to possess scientific value, and this conclusion is one that we think anyone will draw who reads the record of the experiments that were made to start the theory. As was well pointed out in the article before us, it is curious that the missing steam, which experienced steam engineers explain on the ground of cylinder condensation, should be missing equally in engines with drop valves and in engines with slide valves.

Superheating reduces the missing quantity of steam, and this fact is laid hold of by the leakage theorists as proving their case, but they grasp at such very slight straws that one cannot but deem them to feel themselves somewhat in the position of drowning men. Indeed, because a writer on steam declared that the slide valve was not suited for superheated steam, one upholder of the new theory claimed this as an argument in favour of the leakage theory, whereas, of course, the unsuitability is rather due to heavy dragging pressure on a dry surface, and applies almost equally to the Corliss valve.

The *Engineer* calls upon those who so loudly advance a novel proposition to proceed to prove, at least, its general accuracy. This they have never done. We believe that they attempt to discredit the theory of cylinder condensation on the ground that there is not time for it to take place. Such an argument savours of but little practical acquaintance with another part of the practice of steam engineering—to wit, steam making. What of the terrific rate of heat absorption by the earlier parts of a boiler's heating surface, while the furnace gases are rushing past them?

A bank of four or five small water tubes will abstract 60 or 70 per cent. of the heat given up by the furnace gases. Nobody disputes this. Why should anyone dispute the condensation of steam, for which a much longer period is allowed? And what of the rapid destruction of steam in the surface condenser? It is certain that the leakage theory has been put forward on very insufficient grounds, and that the conclusions of Clark and Hirn will require much more powerful artillery to demolish them than has yet been brought to the front.

Rival Systems of Telegraphy.

The recently reported transmission of a wireless message from the Nauen station to the ss. *Cap Blanco*, at Teneriffe, which represents a distance of nearly 2,300 miles, is claimed by a Berlin newspaper to have established a record, and to have surpassed the achievement of the Marconi system between Ireland and Newfoundland. A subsidiary question is raised as a result of the German success, namely, whether this fact will not exercise a slightly favourable influence upon the international position of the German wireless telegraph industry. Will the Teutonic spirit of enterprise, it is asked, derive a useful precedent from the example which England has set to the world by the monopoly of almost all the cables in the globe, or will Germany only learn how to value the possibility of obtaining a cheap means of communication with other countries or her colonies, when British contractors have provided an impenetrable network of wireless stations? The traffic between the two British stations across the ocean has been commenced, and the concession for the utilisation of wireless communication in the Dutch East Indies has been acquired by a group closely associated with the Marconi Co. That a stop has had to be made after these successes in the endeavours of Marconi to encircle the world is mainly due, the Berlin paper states, to the fact that instead of working with the cable companies, as would be reasonable, a hostile attitude has been adopted towards them, it being forgotten that wireless telegraphy is destined, in the first place, to come into operation where it is impossible or would be unremunerative to lay submarine cables. Cases of this kind are to be found in communication between the land and ships and *vice versa*, and between places or countries which only have a slight interchange of traffic. If the wireless telegraph companies base their policy on these lines and develop their systems of communication to a position comparable with that of cables, the cable companies will soon begin to support wireless telegraphy and make it of service to themselves. For instance, it is suggested that where it would not pay to lay two cables, a cable company would be content with one cable and would select the cheaper wireless system in place of a second cable; and it is urged that the tendency should be for the wireless method not to displace cables or wires, but to supplement them for the public benefit where necessary.

Rational Co-operation.

Undoubtedly the public benefits as a result of competition, but there is a point at which competition ceases to be useful. The recent movement in favour of a rational limitation of competition between railway companies ought to result in benefit both to the public and to the shareholders, and the fact of such agreements being possible between railway managers holds out some hope that other combinations may be effected. In the Cumberland Power Bill of 1906, the promoters were successful in securing the adhesion of the ironworks along the coast, to a scheme for pooling their interests in the waste gases of their blast-furnaces, which it was proposed to utilise for the generation of electricity. It seems clear that a concerted action, or a certain pooling of interests in the direction of economy of working, is rendered practicable by means of electrical transmission. To sell electricity to a factory, which has a load factor larger than that of the supply station, may be regarded as a somewhat doubtful experiment, when the factory is large and uses 1,000 or 1,500 H.P., for often such a factory can make its own electricity for less than the supply company can deliver it for. But if the whole range of power-using could be pictured on a 24-hour diagram, by means of lines of a breadth equal to the amount of horse-power drawn along the hour scale, it would be found that water and sewage pumping created certain demands with definite peak loads; that electric lighting had its special hours and peaks, and that all other uses had their special phases, so that the combination of all these demands would give a maximum peak (and other lesser peaks) far less than the sum of all the maxima of the different types of load. By making suitable arrangements with the users, to avoid overlapping of loads, further improvements could be effected. On the present system of power manufacture, each separate works must have power plant capable of dealing with the maximum peak, and a certain percentage of spare plant. The pooling of many interests would not only reduce the total plant, but would enable the percentage of spare plant to be reduced, for large accumulations of plant do not require the same proportion of spare plant as do small accumulations.

It is not to be expected that a steady load can be secured throughout the 24 hours, for, excepting the tramway load, there would remain little but the printing offices and a fraction of the pumping during the night hours from 11 to 4. So many factories require heat that there should be a co-operation between the producers of electricity and of cheap gas, for electricity cannot economically be employed for extensive heating purposes, and the need for heat is undoubtedly one strong obstacle to the purchase of electricity for motive power.

Promoters of electricity undertakings might be well advised to take advantage of the present all-round disposition to co-operate for economical working which undoubtedly exists, and is indicated by the railway agreements. Hitherto the would-be users of bulk electricity have been induced to regard themselves in the light of birds to be plucked by the would-be exploiter, rather than as brands to be snatched from the burning. This idea was fostered by the London County Council, who, however, were even less pleasantly regarded. Yet there are great opportunities ahead if a sufficient intelligence can be brought to bear in the direction of a rational co-operation.

Copper. The copper market has assumed a much firmer tone, as evidenced by the maintained price in face of remarkably large visible supplies. Stocks accumulated during the rise are largely disposed of, and the restriction of output is beginning to have an influence, together, probably, with some apprehension of political disturbance. The consumer is beginning to renew stocks, although the activity of trade still leaves much to be desired. The price being possible to him, and chance of a further fall somewhat problematical, the policy is a prudent one.

Messrs. Merton's mid-monthly report gives supplies at 20,870 tons, a figure which has not been approached for two years, and which is an advance of 1,000 tons on the quantity for the end of December. Australia maintains shipments, whereas Spain shows a small figure under this heading. North American deliveries to British ports are heavy.

A NEW METHOD OF SUPPORTING OVERHEAD CONDUCTORS.

The opening of extensions on the Derby Corporation Tramways has opened also a new era in the construction of overhead trolley lines, and we rejoice to think that means have been found to reduce the constantly increasing cost of maintenance of our overhead equipment, by overcoming some of those acute troubles with which we have dealt in these pages from time to time.

For many years the trolley wire in use was of a circular section, equivalent to No. 0 S.W.G. or thereabouts, and the gun-metal ears which formed the attachment between the wire and the insulator clasped the wire round the whole, or the greater part of its circumference, and presented an actual obstacle, usually from 12 in. to 18 in. in length, to the passage of the trolley wheel. This obstacle the wheel had to jump on to and off from, with the result that a blow, which varied in intensity with the inertia of the spring-controlled trolley boom, and with the speed of the car, was struck at every suspension, and when the inertia of the wheel was sufficient to carry it clear of the ear or the wire, an arc was formed between the fixed and moving surfaces, if at the time current was passing to the motors. The destructive effect of this arc was manifested by degrees on the wheel and on the wire, but was, of course, of little relative importance on the former.

So long as speeds and current densities were low, and, we may add, so long as poles and bracket-arms were light and whippy, the consequences of this crude method of attaching the ear to the wire were not particularly noticeable, but of late years a very different condition of things has arisen, and even a vastly more expensive and thorough system of inspection than any that was undertaken ten years back, has failed to prevent wires breaking with disconcerting frequency. The most astonishing feature of this history is the failure to develop, or at least to adopt, an ear which should not interrupt the smooth passage of the trolley wheel. As this ear could not be found, the extraordinary expedient of altering the shape of the trolley wire was adopted, and tramways began to be constructed upon which the overhead conductor was grooved like the section of a cottage loaf, or drawn with the section of the figure 8, but not before our engineers, in despair, had begun to use heavier sections of circular wire with the idea of spreading the wear at the points of suspension over a longer period. We say that the use of peculiarly-shaped wire was an extraordinary expedient, because the trouble was due to the ears alone, and did not occur over the remaining 39½ yards of the 40 yards span. Grooved wire was found to have little effect in reducing the bump of the trolley wheel, as in most cases the ears still protruded themselves into its path. With figure 8 wire there was less excuse for designing the ears so badly, and smooth running resulted, but the necessity for a permanent enlargement of the original No. 0 section remained, not so much because the extra copper was required for current, as that the tensile strength of grooved wire is relatively less than that of circular wire.

In a paper on "Overhead Equipment," read in 1906 before the I.E.E., Messrs. Tweedy and Dudgeon showed that the prevalent belief that a soldered ear must encircle more than the top half of the wire was probably unfounded, and they mentioned tests made on an ear which was soldered only to the semi-circumference of circular wire, proving that the wire broke before the ear gave any indication of parting from it, and these tests were carried out on shorter and shorter ears until a length of only 4 in. was reached. Mr. P. J. Pringle has confirmed these results independently.

It is strange that engineers should have gone to such pains to avoid making use of this simple method of obtaining a smooth, uninterrupted path for the trolley wheel, and there must be some reason for it. Probably there are two reasons, one that almost everyone distrusted the soldered ear, the other that the vertical motion of the trolley wire at the ends of the ears (of which we shall say more, in another relation, later) produced a peeling action, which extended the whole length of the ear until it parted from the wire. Presumably it was to retard the beginning of this action that someone first put saddle pieces or clips at each end of soldered ears which entirely surrounded the wire. These saddles presented additional obstacles to the wheel, and in the long run were worn away.

The distrust of soldering is widespread still, and we are convinced that it arises from a lack of education in the elements of the matter. Commonly enough it is said that a careless wireman will burn the wire with his iron, but this simply means that the copper must be melted, and we have never heard of this being done. A man who could do work like that would ruin anything, and would not stay long on a job. Again, it is said that soldering, if it does not "burn" the wire, is apt to soften it, but the answer to that is to point to the thousands of soldered ears which have been in use for long periods, and the absence of any sign of elongation at the fractured ends of the wires which have broken at the ends of these ears, showing that the cause of the fractures has not been reduction of the tensile strength due to softening.

A propos of this, we may quote Mr. Popplewell's remarks in the course of the discussion of Mr. Trotter's paper on the "Construction of Overhead Transmission Lines" (*Proc.* Inst. C.E., Vol. CLXIX) :—

"It might interest readers of the paper to mention the results of some experiments upon copper trolley wire made in the Materials Testing Laboratory of the Manchester Municipal School of Technology. The object of the experiments was to find out how the ductility and strength of trolley wire were affected by annealing, by wear and tear on the straight run, and by the soldering of the wires on to the ears. The wire tested was that used by the Manchester Corporation Tramways, and the results of the experiments

were summarised in the accompanying table. Of the wires tested, A was a length of new wire which had been softened by heating and quenching, B a length of new wire in its hard-drawn state, C a piece which had been soldered under the suspension-ear and had been used for about two years, while D was a straight length which had been in use for the same time. In the case of the last two it was found that a considerable reduction in the area of cross-section had taken place by reason of the wear caused by the trolley wheel, amounting to about 9 per cent.

Specimen ...	A.	B.	C.	D.
Initial diameter (in.)	0·403	0·401	0·365—0·396	0·374—0·399
Initial area of section (sq. in.)	0·127	0·128	0·114	0·117
Maximum load (tons)	1·80	2·90	2·50	2·50
Stress at maximum load, tons per sq. in.	14·10	22·60	21·90	22·20
Elongation at maximum load (per cent.)	35·20	2·80	1·54	1·49
Elongation after rupture (per cent.)	45·80	5·70	4·06	3·50
Limit of proportionality tons per sq. in. (about) ...	—	7·80	7·80	6·80
Modulus of elasticity, lb. per sq. in.	—	16,000,000	16,000,000	17,000,000

The mere heating of the wire will not soften it, and Column C shows well how little soldering, done with no more than the usual skill, by the ordinary lineman, affects the strength of the wire.

Mr. Pringle set up an ingenious apparatus for the purpose of testing the influence of soldering on both round and grooved trolley wire, and we have his permission to quote the following results of tests on wires of No. 000 B. & S. section subjected to 1 in. motion—*i.e.*, ½ in. up and ½ in. down, a length of 10 in. being clamped almost rigidly. The speed of bending was approximately 150 alternations per minute :—

Circular Wire.

(1)	Hard	15,658 alternations.
(2)	„	16,487 „
(3)	Soldered—blackens paper* ...	22,225 „
(4)	„ „ „	27,634 „
(5)	„ lights paper†	7,838 „
(6)	„ „ „	5,734 „

* "Blackens paper" is a dull red heat.

† "Lights paper" is a bright red heat.

Grooved Wire.

(1)	Hard	12,045 „
(2)	„	5,894 „
(3)	Soldered—blackens paper	8,728 „
(4)	„ „ „	6,272 „
(5)	„ lights paper	3,021 „
(6)	„ „ „	3,427 „

These figures show, in the first place, that when soldering is carried out in the usual manner, with the iron at a dull red heat, the wire is not depreciated, and, secondly, that round wire is superior to grooved wire. We conclude, therefore, that it is unnecessary and even harmful to use anything but circular wire; that by soldering only the semi-circumference a non-fouling ear can be attached with an ample margin of tenacity to round wire of the smallest section in use, if the "peeling" difficulty mentioned above can be overcome, and that, apart from considerations of current-carrying capacity, the very heavy sections now becoming the rule are not justified.

Another dive into history is now essential before we are fully prepared to describe the system of suspension which we have said marks a new era in tramway construction. When electric traction on the overhead system emerged from its experimental forms, the wire was attached to, and insulated from, its support by a single insulator, which was practically one with the bracket-arm. At a pressure of 300 volts this single insulation gave satisfactory results, but the introduction of higher pressures led to serious and frequent failures in many localities, and these were not always prevented by the insertion of a fibre sleeve between the arm and the hanger. Span-wire construction offered at one and the same time the opportunity of obtaining effective double insulation, and easier running for the trolley wheel on account of the increased flexibility of the suspension. This led on to the bow-string suspension on bracket-arms, which solved the problem of double insulation without the use of two poles, and was said to give flexibility as well. Indeed, many people still believe, without, however, having thought much about the matter, that the bow-string suspension was developed primarily for flexibility, and that double insulation was incidental. Doubtless in those cases in which the bow-string is carried fromthe free end of a long bracket-arm right back to the pole there is a certain amount of "give" at the points of suspension, but these points are, as a rule, so near the end of the arm that the difference between this form, and the more usual form, in which the total span is 1 ft. 6 in. or 2 ft., is minute.

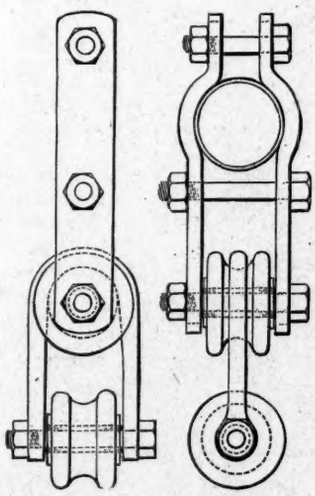


Fig. 1.—Details of Bracket-Arm Hanger.

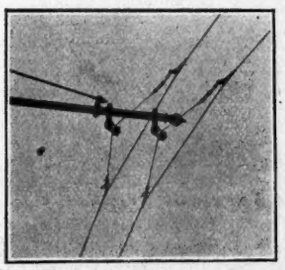


Fig. 2.—Bracket-Arm Suspension on a Curve.

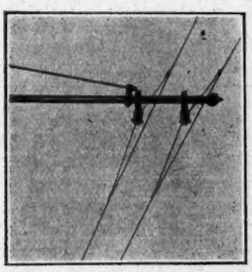


Fig. 3.—Bracket-Arm Suspension on Straight Line.

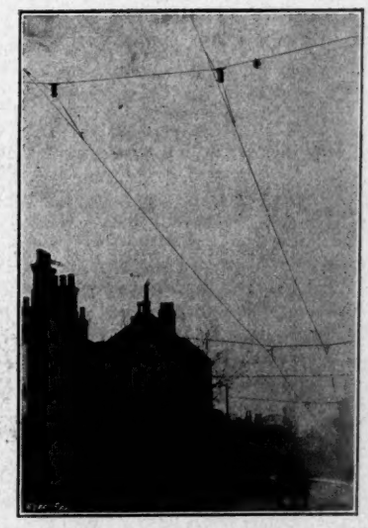


Fig. 4.—Tangential Span-Wire Suspension, Derby Tramways.

Certainly with the latter, strained up taut as it always is, the rigidity of the hanger is practically as great as if it were attached directly to the arm in the old way.

Composition hanger bolts enclosed by two metal parts have been in general use for 12 years at least, and for a long time it was considered necessary to apply adjustable strain insulators at each end of the suspension wire. This custom survives very largely at the present day, although it has never been of real value, and often has been the direct cause of trouble; but in some instances porcelain-ware reel insulators have superseded the "Brooklyn," the insulated turnbuckle, and the non-adjustable "globe strain," with superior results. Attempts have been made to use porcelain for the primary insulation, but without success, when applied to the usual plan of suspension.

As a trolley wheel held against the wire by a pressure of 20 to 30 lb. travels along a span, its distance from the ground varies due to the weight and sag of the trolley wire, and it sets the wire in motion upwards and transmits a vibratory wave along it in both directions. If the wire were suspended freely these vibrations would travel until damped out by molecular friction and air resistance, and the distance would be very great; but the suspensions found in practice are by no means free, so that damping takes place rapidly and is concentrated at the ends of the ears, at which points also a definite and considerable hingeing action is caused by the upward pressure of the trolley wheel. The energy of these movements is partly dissipated in the trolley wire at the damping point, and in time its molecular structure is changed by fatigue, and becomes crystalline.

Mr. Sheardown was the first person, within our knowledge, to use this theory of fatigue to account for the frequent fractures which he had experienced in Dublin, and he is now backed by a large body of opinion. It is clear, therefore, that the evil lies in the method of suspension, which, in the first place, creates a considerable sag between supports, and, secondly, is relatively inflexible—relatively, that is, to a theoretically freely hanging wire.

Hitherto the almost rigid bracket-arm, or bow-string, or tight span wire has confined the trolley wire at the point of suspension both horizontally and vertically. The wire has been unable to cushion the blow of the trolley wheel by rising to its pressure, and the wheel has struck it hard at the trailing end of the ear. It has been unable to transmit past its supports more than a small portion of the vibration set up by the trolley pole and wheel.

Take, now, a trolley wire anchored on both sides of a bracket-arm, and unscrew the hanger from the central ear. The wire floats, and is no longer cramped for movement in any direction. The supporting forces are now approximately tangential to the wire, and it is free.

That, in effect, is Pringle's tangential suspension, to which public attention has been drawn by the opening of the Derby extensions, constructed as to the overhead work entirely on this system.

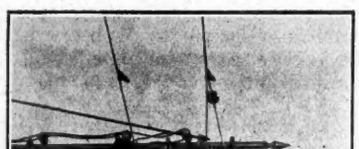
Gone are the bump and arc of the trolley wheel, for the ears are all non-fouling, albeit the wire is circular!

Gone are the composition insulators of several parts, for double insulation is obtained on side-arm, and centre-pole and span-wire, by porcelain reels, and adjustments are neither wanted, nor is provision made for them unnecessarily!

Gone is hingeing action, which produces crystallisation, which ends in a fallen wire; and gone is a great deal of the damping action which led to the same things.

Our illustrations demonstrate the advantages claimed by Mr. Pringle, which, in brief, are:—

1. Universal flexibility at supports, and more uniform flexibility throughout the system.
2. Removal of causes bringing about trolley wire fractures.
3. No renewals of ears, as, even on circular wire, they do not foul the trolley wheel.
4. An old line may be rejuvenated.
5. The insulation does not deteriorate.
6. The sag is reduced.



Figs. 5 and 6.—Examples of Old and New Suspensions. Fig. 7.—Pull-Offs using Existing Hangers, Curves 1 in 4½.

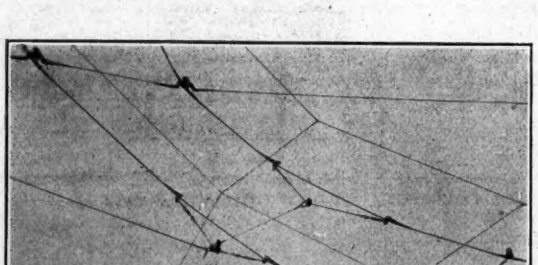


Fig. 8.—Curve with Tangential Pull-Offs.

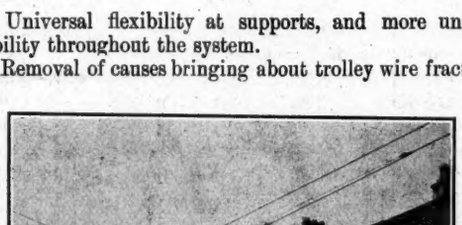
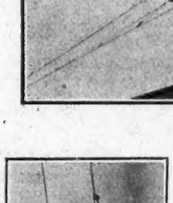


Fig. 9.—Span Suspension, Both Types.



Figs. 10 and 11.—Examples on Curves.

7. The angle which the old form of suspension would have made at a curve is halved, thus minimising the risk of trolley wheels de-wiring, and permitting higher speeds.

8. The system is as adaptable to grooved or figure-8 wire as to circular wire.

9. The cost of construction is about the same as the cost of the old system.

Measured from tip to tip of the ears, the spread of the suspension is about 10 ft., and the central point of the suspension is 4½ in. to 6 in. clear of the trolley wire.

For straight line work an ordinary non-fouling ear can be used, although Mr. Pringle has developed one which does away with nozzling, and brings the pull within the wire; but for work in which the line deviates from the straight more than a few inches a special ear is used, which maintains a vertical position in spite of the side pull of the suspension, and this ear permits of adjustment to suit any curve.

The ears are 8 in. long, and the groove is milled out a trifle larger than the trolley wire, both being tinned before soldering is begun. Two small clamps hold the wire tightly in the groove during soldering, so that the two surfaces are in true contact. Tests have been made with No. 000 wire soldered in this way into 8-in. ears, and the ear casting has broken at 3,000 lb. strain with no sign of the soldering giving way. With pull-off ears 12 in. in length, and of a stronger pattern than the 8-in. ears, similar tests were made, and in these cases the trolley wire fractured at 6,000 lb. strain, leaving the soldered parts intact.

In order to reduce still further the cost of construction, Mr. Pringle is using, experimentally, a malleable-iron ear, which, when soldered, has given, under strains which broke the trolley wire, results equal to gun-metal ears.

The possibility of rejuvenating existing work by the adoption of the tangential suspension appeals to us very strongly, now that new work has dwindled to a few miles per annum. We hear on all sides that No. 00 and 000 wire is breaking after less than two years' service, and that whole sections of line are being renewed within five years of erection, and it seems to us that this freely suspended system with its non-fouling ears is destined to save our ratepayers a great deal of money in the future, for the whole trouble is in the vertical rigid, or almost rigid, suspension and in the stupid fouling ear.

By replacing the old system with tangential suspension a practically new overhead line is got without a single length of new wire, and quite irrespective of the wear which has taken place already. It ensures that the future wear of the trolley wire in the neighbourhood of the new ears will be no more than the normal wear occurring over the wire as a whole; and the causes of the present rapid molecular change in the metal adjoining the points of support will be removed.

The Derby extensions are about three route miles in length, half being side-arm and half span-wire. We have travelled over the whole, and find that the merits of the tangential suspension are fully sustained in practice. The trolley pursues an absolutely smooth course, running as sweetly under the suspensions as in the middle of a span; there is no sparking, and the whole line floats freely and cushions the wheel at every point. The Board of Trade passed the novelty without hesitation, and the extensions have been in use since the day of the inspection.

The preliminary experiments were carried out on a large scale by Mr. Pringle on his lines at Burton-on-Trent, and he has been able to increase the safety and speed of the service to the maximum by introducing the system at all awkward curves and on steep hills, and at section insulators.

Fig. 1, p. 125, shows the construction of a Pringle bracket-arm hanger; figs. 2, 3 and 4 show the system as it exists on the Derby lines; but figs. 5, 6, 9 and 10 are even more interesting, as they afford comparison between the ordinary system and the tangential system under exactly similar conditions. It is easily seen from these photographs how the tangential suspension reduces the sag, and halves the angles round curves.

We congratulate Mr. Pringle on the material success which has at last crowned his strenuous and protracted efforts to produce a system of suspension which should approach the ideal which he set up for himself.

REVIEWS.

Technical Dictionary in Six Languages. Vol. II: *Electrical Engineering.* By K. Deinhardt and A. Schlomann. Edited by C. Kinzbrunner. London: Archibald Constable & Co. 1908. Price 25s. net.

Ever since the appearance of the first volume of this work ("Machine Elements and Tools," 1906) we have looked forward eagerly to the promised publication of the present work, which deals with Electrical Engineering, "including Telegraphy and Telephony." We should have thought it superfluous to add the latter to the title; surely it goes without saying that these subjects are integral and essential parts of electrical engineering—but this by the way.

In our notice of the first volume we expressed our appreciation of the excellence of the arrangement adopted by the authors; to this we have nothing to add. We need only repeat that the system is admirable. Everyone who has had occasion to translate technical articles from foreign languages into English, or *vice versa*, with the aid of the dictionaries hitherto available, is well aware of the frequent and exasperating occurrence of lexicographical errors, due no doubt to the impossibility of one man's being perfectly acquainted with the whole of any subject in more languages than one—or even in one. But when a sketch of the unknown is presented together with the corresponding word, the technical reader knows at once what is referred to, and can generally correct the translation—at any rate, when he is translating into his own language, the most common case. This, in fact, is the most striking feature of these new dictionaries. When we add that a permanent staff of over 30, including ten engineers and scientific men, and several hundred foreign co-operators, have taken part in the work; and that the list of contributors and revisers includes such names as those of Mr. L. S. Walter (editor of *Science Abstracts*), Dr. F. Niethammer, Mr. H. M. Hobart, Prof. A. Blondel, Prof. Eric Gérard, Prof. L. J. Spoerhase, Prof. G. Colombo and Don R. Yesares—to pick out only a few names—as well as scientific institutions, numerous companies and other authorities in ten countries, we shall, we believe, convince the reader that the accuracy of this work is likely to prove unexcelled, and hitherto unattained. In fact, it will go far to make good the loss of the "Technolexicon," which, as we recently reported, has broken down under the excessive burden of cost and labour that its preparation entailed.

We do not propose to criticise the work in detail; only by constant use over an extended period can a fair estimate be formed of its accuracy and completeness. So far as we have examined the contents, the definitions are correct and adequate; in very many cases not only words but compound expressions are given—a valuable feature. The present volume, which comprises 1,360 pages of definitions, averaging 9 or 10 to a page, and 740 of vocabulary—2,100 in all—unfortunately does not include electric traction, owing to the exigencies of space; this subject is to be included under "Railway Engineering," which is in course of preparation. Attention should be drawn to the few pages of errata at the end of the book, which might escape notice. In conclusion, we emphatically recommend this dictionary to our readers.

Transactions of the American Electro-Chemical Society, 1906. Vol. IX. Ithaca Meeting, May, 1906. Vol. X. New York Meeting, October, 1906. (Price 12s. 6d. each net. Free to members of the Faraday Society.)

The *Transactions* of the vigorous and enterprising American Electro-Chemical Society continue to be of the same varied interest and value that has characterised them since the very first issue, and, we may add, they are no less strong on the practical and experimental side, as they are—well, a little uncertain, let us say—on the theoretical side, than they ever have been. A list of the names of the 50 papers or thereabouts in these two volumes would probably come as a surprise to many people in this country who little realise the wide field that practical electro-chemistry now covers. We cannot, of course, in a brief review do more than just draw

attention to one or two of the more noteworthy out of a whole host of interesting papers. An important and most capable paper is a theoretical "Study of Resistance Furnaces," by Mr. C. L. Collens, in which the author deduces some general equations that should prove of considerable value to those engaged in the design of this type of furnace. A paper by Mr. E. A. Ashcroft on "Sodium Production" describes, in as much detail as the exigencies of business considerations will allow, his own very ingenious process. In this, unlike the Castner process which now practically holds the field and in which caustic soda is the electrolyte, the universal common salt is the raw material. This is electrolysed in a double apparatus, in the first of which the sodium alloys with molten lead, while the clever device of setting up a strong magnetic field in the cell maintains the liquid cathode and the electrolyte in circulation. Mr. Sperry's note on "Electro-chemical Processes as Station Load Equalisers" raises points well worthy of the consideration of electrical engineers who are worried by peaks. The electric vacuum furnace, which Mr. Aisem, of the American G.E.C., describes, is a new type of furnace now coming into use both as an instrument of research and for some small industrial processes. A suggestive paper by Prof. C. F. Burgess and Mr. O. P. Watts discusses the structure of electro-deposited metals, but it deals only with the outskirts of the subject, and we still await a really comprehensive study of a matter second in importance to none with which the electro-metallurgist has to concern himself. There are now several electro-chemical laboratories in England, and a subject such as this is pre-eminently suitable for research students to tackle under able guidance. A controversial paper by M. Le Blanc discusses the possibility of depositing by electrolysis thick layers of coherent metallic chromium, and the author concludes—a conclusion not shared by his critics—that this cannot be done. Of broader interest are several useful papers on Pyrometry, and, lastly, we have a detailed description by Prof. Crocker of an improved and quite business-like variety of primary battery of the bichromatic type, made by Mr. F. A. Decker, which, judging by the tests submitted, should help to popularise the use of batteries in those many cases where their trouble and cost at present put them out of court.

Altogether, the varied fare provided in these *Transactions* is well worthy of careful study by everybody who wishes to be posted in what practical electro-chemistry is doing in the most go-ahead country in the world.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to this column should be written on one side of the paper only.*]

"ENGINEER" writes:—"A consumer decides to take a supply of energy from a public authority for the purpose of driving and lighting his works. These works consist of several detached buildings, separated one from the other by distances varying from 6 ft. to 100 yds. The energy is conveyed from one building to another by means of bare overhead wires attached to, and suspended by, insulators fixed by suitable means to the outer wall of each building.

"A public footpath, some 8 ft. wide, runs by the side of the works' boundary wall, and across this footpath bare overhead wires have been suspended to carry energy from one building within the boundary walls to another building on the far side of the public footpath. These bare wires are suspended some 30 ft. above the level of the footpath, and are fixed and attached in the manner described above to this latter building, which abuts on the footpath. Between the two buildings, to which these bare wires are suspended, some G.P.O. telephone wires cross at a height of about 8 ft. above the bare mains, but the actual point of crossing is situated within the works' boundary walls.

"1. Are the whole of these bare wires (both within and without the boundary walls) 'electric lines' within the meaning of, and subject to, Sec. 4 of the Electric Lighting Act of 1888, or only that portion (about 8 ft.) which crosses the public footpath?

"2. If they are within the meaning, &c, can they be fixed only in accordance with the rules and regulations made by the Board of Trade in respect to the powers conferred on them by the above Section of the Act of 1888?

"3. If the whole of these bare overhead wires are subject to Board of Trade regulations, am I right in assuming that a person who takes a supply of energy from a public supply authority can distribute this energy to the various buildings within his boundaries only, in accordance with the regulations—as the regulations apply to all 'electric lines' laid underground as well as erected overhead, except in the case of those lines 'entirely enclosed within any building'?

"4. I gather that these regulations do not apply to any electric lines, whether underground or overhead, where the energy is generated on the premises where it is consumed, but it would seem that a person deciding to discard his private plant can take a supply of energy from a public authority, but only distribute the same between the various buildings, provided his underground or overhead wires comply with the Board of Trade Regulations. Is this correct?"

*** As to (1), it is clear that all the lines referred to by "Engineer," in so far as they are not "entirely enclosed within any building or buildings," must comply with the regulations, if the Board of Trade make a requirement in that behalf. The proviso to Sec. 4 of the Electric Lighting Act, 1888, only excludes to premises whereon a supply is both generated and distributed.

As to (2), it is to be noticed that Sec. 4 of the Electric Lighting Act, 1888, does not come into operation until set in motion by the Board of Trade. It empowers the Board, if they think fit, to serve upon the body or person owning or using the line, a notice requiring the same to be used only in accordance with the regulations. Until such a notice is served, there seems to be no need to alter the wires.

As to (3), it seems that Sec. 4 places no restriction upon the consumer distributing the public supply both within and without his premises. Seeing that the public authority is probably the highway authority as well, it is not likely that the suspension of a main over the public footway will be objected to.

As to (4), the assumption appears to be correct.

"E. A. E." writes:—"We have a gas company supplying the lamps and gas for lighting the streets. The Parish Council of my district pay for this. It is being proposed to light a greater part of them by electricity. I have cables laid underground throughout all the principal streets. These cables are my private property; the business likewise. I am not working under a provisional order; the consumer obtains permission to lay the cables from the District Council, I laying the cables and supplying the light. We do not consider the business large enough yet to have a provisional order. Would it be possible to do the street lighting under these conditions, or must I obtain a provisional order?"

*** In view of the facts stated, there appears to be no reason why "E. A. E." need incur the expense of a provisional order. The principal reason for obtaining an order is to enable the supplying body to obtain powers to open up streets and highways for the purpose of laying mains. Here the mains appear to be laid, and so far from opposing the scheme, the local authorities appear to cordially approve it. There is nothing in the Electric Lighting Acts to prevent a supply of electricity being furnished to the street lamps.

FIRES ON LONDON UNDERGROUND ELECTRIC RAILWAYS.

THE following is the Board of Trade report (dated January 17th, 1908) to which reference is made in a leaderette in this issue:—

Board of Trade,
8, Richmond Terrace,
Whitehall, S.W.,
January 17th, 1908.

We have, in the usual course of our duty, inquired into the circumstances under which an explosion and electric flashing took place in a car, on the evening of January 8th, at Sloane Square Station, on the Metropolitan District Railway.

We made a very careful examination of motor-car No. 34, which alone was concerned in this case, before any repair work had been carried out, or any of the effects of the explosion and flashing had been removed.

Above floor level there was some blistering of the varnish on the woodwork surrounding the end left-hand window and doorway, and two panes of glass were blackened with smoke and fumes. No glass was broken, and it was possible, by rubbing off the blistering on the wood, to see that the red paint-work underneath was undamaged.

Below floor level the metal pipe carrying the electric lighting wires and a metal junction box were fused. The underside of the timber flooring, immediately above this pipe and junction box, was charred in places. The charring nowhere exceeded ¼ in. in depth. No mark of fire could be found inside the car, on the flooring, seats or sides.

We may here remark that all the woodwork on the company's cars in proximity to electric conductors has been rendered non-inflammable. This and other occurrences of a similar kind have proved that the wood will char under the effect of intense heat from electric flashing, but will not catch fire. The real combustibles in this fire, if we use the word, were copper, iron and brass. Such electric arcs continue until they exhaust or burn themselves out, or until the current is cut off, as was done at Sloane Square. The ordinary method of extinguishing a fire is useless for electric arcs.

This particular case was caused in all probability by failure of the insulation of the electric lighting wires owing to damp. The

heating of the wires resulted in the liquefaction of a small plug of bitumen. An explosion of bitumen vapour followed, causing smoke and fumes. Subsequently electric flashing took place along the pipe and at the junction-box under the car.

The conductor in charge of the car states that he immediately entered the door at the corner where the explosion had taken place, and worked the air valve which actuates the double doors in the centre of the car. The doors opened in the usual way; they had not to be forced or held apart. The passengers, eight in number, stepped out on to the platform through the open doorway, without any apparent panic or alarm. No complaint of injury or danger was made to either the station inspector or any of the company's officials.

Arrangements also exist, on underground as well as on tube railways, to allow passengers, in case of need, to descend from a train at either end.

In our opinion, the apprehensions of danger which have been expressed by writers to the newspapers are not justified by the facts. The main danger in any such cases of fire will be from panic. For this reason we deprecate the writing for publication of alarmist letters.

(Signed) J. W. Pringle,
Major,
Inspecting Officer of Railways.

(Signed) A. P. Trotter,
The Electrical Adviser to the Board of Trade.

To the President
of the Board of Trade.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

E.C.C. Ball-Bearing ("S.P." Type) D.C. Motor or Dynamo.

In the accompanying illustrations (figs. 1 and 2) we show a new machine recently put upon the market by the Electric Construction Co., Ltd., of London and Wolverhampton. It has been designed to meet the demand for a machine of moderate cost, which at the same time shall be highly efficient and mechanically strong. The manufacturers claim that this combination of qualities has been attained, and we understand that good orders have already been booked.

The feature of the general design of the "S.P." machine which first attracts attention is, of course, its ball bearings. We understand that the decision of the makers to adopt this type of bearing has only been arrived at after careful comparison and experiment, and they are convinced that it will prove entirely satisfactory. With

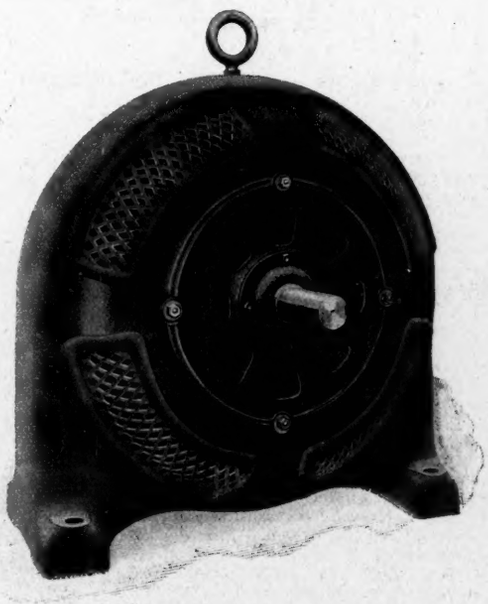


Fig. 1.—E.C.C. Ball-bearing Motor.

ball bearings frictional losses are materially reduced; no oil is necessary, the bearings being filled with grease, which serves for long periods without replenishment, and which cannot creep to the commutator or windings; the overall length of the machine is reduced; and—a valuable characteristic—the machine, without any adjustment of the bearings, will work in any position, provided the shaft is horizontal. The "S.P." machine has been specially designed to secure these advantages.

In regard to the general design of the "S.P." motor or dynamo, the machine may be open, enclosed ventilated or totally enclosed, according to requirements. The magnet yoke is of cast-iron, with circular steel poles and laminated pole shoes; the bearing brackets are carried by arms cast with the frame, and the ball bearings are so fitted to these brackets that there is no possibility of dust getting into the ball race. The bearings are of the best quality obtainable, and are liberally designed for the whole range of outputs and speeds. The brush pillars are carried directly from the bearing brackets.

The armature has a slotted core, and the coils are barrel type, former wound and interchangeable. The commutator is built up of hard-drawn copper bars having a good margin of wearing depth, and the mica between the bars is specially selected so as to give

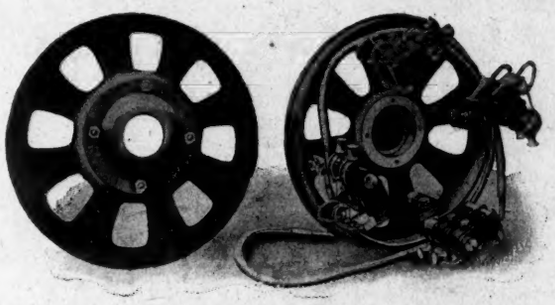


Fig. 2.—Bearings of "S.P." Machine.

even wear. The field coils are wound on formers and are easily removable from their respective poles.

Commutating poles are not fitted in the smaller sizes. The reason given for this is as follows: Up to a certain size, the limit of temperature is reached before the sparking limit, and in a properly constructed machine for ordinary duty there is no danger of sparking, provided the design has in view a reasonable heating maximum. Further, the labour cost involved in fitting commutating poles to small machines is out of all proportion to the saving in copper. In larger sizes, however, where ordinarily the sparking limit would be reached before the temperature limit, commutating poles are fitted, with a resultant saving in manufacturing cost. By thus limiting the use of commutating poles to certain sizes, the makers claim that for any given output they are able to offer an entirely efficient machine at a reasonable price.

Direct-Current Ampere-Hour Meter.

The new type of D.C. ampere-hour meter made by Messrs. Ferranti, Ltd., for house service has become very popular, many thousands of these being in operation at the present time. For switchboard use, and in situations where a highly-finished instrument is desired, Messrs. Ferranti have now placed upon the

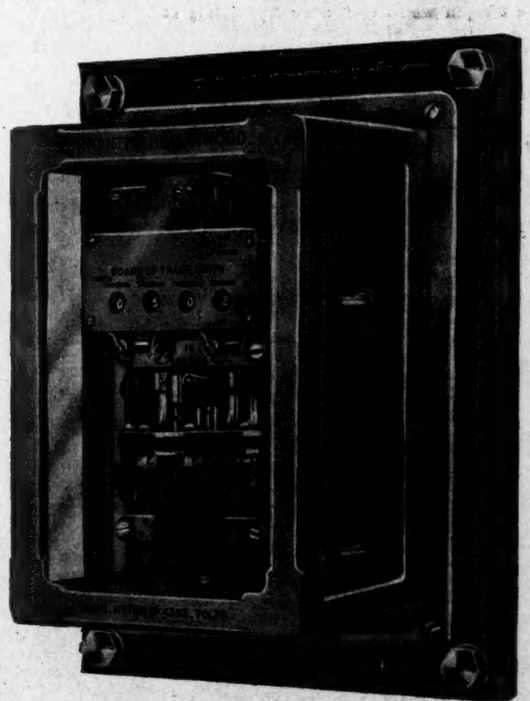


Fig. 3.—Ferranti Switchboard Meter.

market the instrument illustrated herewith. This is supplied with a cyclometer dial, is mounted on a slate base, and is enclosed in a glass and polished aluminium frame. All the parts are heavily nickel-plated or enamelled, and the whole presents a very highly-

finished appearance. One advantage of this type of instrument is that it can be placed in any convenient position on the switchboard, as the shunt is separate from the instrument, and is connected to the latter by a pair of flexible leads. The standard sizes go up to 6,000 amperes.

ELECTRICAL EXHIBITS AT THE PARIS MOTOR-CAR SHOW.

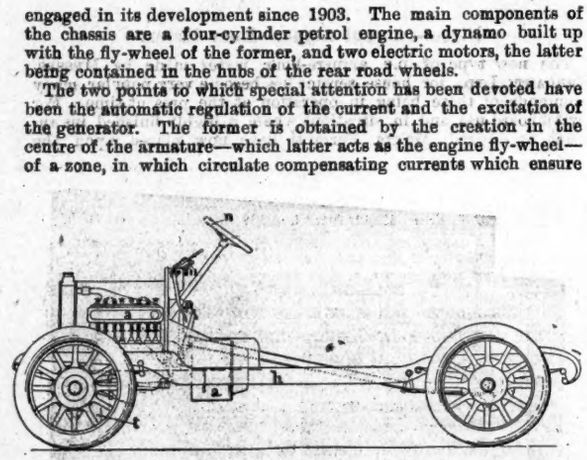
(*Concluded from page* 114.)

The Balachowsky-Caire Petrol-Electric Vehicles.—La Société Electromotion, of Ronte de la Revolte, Neuilly-sur-Seine, has secured the concession for France for a new petrol-electric vehicle, designed by Messrs. Balachowsky and Caire, who have been

FIG. 19.—KRIEGER PETROL-ELECTRIC LANDAULET.

engaged in its development since 1903. The main components of the chassis are a four-cylinder petrol engine, a dynamo built up with the fly-wheel of the former, and two electric motors, the latter being contained in the hubs of the rear road wheels.

The two points to which special attention has been devoted have been the automatic regulation of the current and the excitation of the generator. The former is obtained by the creation in the centre of the armature—which latter acts as the engine fly-wheel—of a zone, in which circulate compensating currents which ensure



FIGS. 20 AND 21.—ELEVATION AND PLAN OF KRIEGER PETROL-ELECTRIC CAR.

the diminution of the flux at the moment when the amperage rises, and maintain constant the power absorbed by the generator, the speed of the engine being constant. This regulation is claimed to be so exact, as to be in operation, at all the various speeds, even at the slowest. Thus there is no weakening of the E.M.F. when the speed of the engine is reduced, the power of the latter being constantly utilised at its maximum efficiency. As soon as the engine, after it is started, attains a speed of 180 R.P.M., the dynamo develops sufficient power to drive the car at a low rate—from about ½ to 1½ miles per hour; this quality of self-excitation at a low speed is obtained without the employment of a battery of accumulators supplying energy to a special winding. The dynamo weighs 3 cwt., and can develop 30 KW. at the normal speed, with, it is claimed, an efficiency of 90 per cent. Only four brushes are employed, their position being definitely fixed after experiment to ascertain the exact point. The energy generated is transmitted direct to the motors, the armatures of which form the hubs of the rear road wheels.

A feature of the system is the absence of the controller usually found on electric and petrol-electric cars, the speed of the car being entirely controlled by varying the admission of gas to the engine. A double set of brakes is provided on the rear wheels, these being so arranged that, on their being applied, the current to the motors is automatically cut off.

The Krieger Petrol-Electric Vehicles.—While still building electrical carriages, La Compagnie Parisienne des Voitures Electriques Procédés Krieger, of Boulevard de Valmy, Colombes, and Rue la Boetie, Paris, has for some years been also developing a series of combination petrol-electric vehicles (fig. 19). The motive power is supplied by a four-cylinder petrol motor, which works constantly at full power. It is connected through a flexible coupling to the armature—which forms the fly-wheel—of a special dynamo. The latter is of the self-regulating type, designed to utilise the whole of the power developed by the engine, either in increased speed or in greater driving effort, according to the nature of the road over which the car is being driven. It is provided with a differential compound winding, a few demagnetising turns in series with the armature opposing the shunt coils.

Two electrical motors are provided; these are coupled in parallel or in series work at constant power but variable speed, driving the two front wheels—which thus act both as steerers and drivers—through enclosed helical gearing. The speed is regulated by a pedal connected with the controller. The latter is mounted on the dashboard, and comprises a special contact for the dynamo and a reversing switch, the latter being controlled by a small lever on the dashboard. By gradually pressing down the pedal, the speed of the engine, and consequently that of the car, is progressively increased, while by removing the foot therefrom the current is diverted from the motors and the engine slowed down. A further variation in speed is obtained by a lever which alters the degree of excitation of the dynamo. The number of contacts has been reduced to two—one for forward running and one for reverse—and the current is diverted whenever a change has to be made from one to the other. Under no circumstances, however, is the electrical circuit totally interrupted.

Two sizes of chassis, for cabs, town carriages and pleasure vehicles are being made, of respectively 12-16 H.P. and 16-26 H.P. The system has also been adapted to motor-omnibuses and heavy wagons of respectively 15 H.P., 20 H.P. and 30 H.P.; in these the motors are located at the back, and drive the rear road wheels through double-reduction gearing.

The S.F.A. Petrol-Electric Car.—The principle of the S.F.A. petrol-electric vehicle, designed by M. Theodore de Poorter, and recently put on the market by the Société Française d'Automobiles, 60, Rue Lemercier, Paris, is very similar to that of the G.E.M. car already described—that is to say, under normal conditions the petrol engine drives the rear axle of the car direct through a universally-jointed shaft and bevel gearing. On starting, however, or on any occasion when the load on the engine is greater than it can meet, a certain amount of reserve power is furnished by a small set of accumulators carried on the car. *Per contra*, when the driving of the vehicle does not absorb the whole of the power developed by the engine, as when on down grades, the excess is employed in charging the battery. The general appearance of the car is similar to the usual design of petrol vehicle. Interposed between the engine and the cardan shaft is an electric machine specially designed to act either as generator or motor. When a hill is, for example, encountered, the engine, and consequently the generator, will slow down, a corresponding fall taking place in the E.M.F. at the brushes. As at the terminals of the battery there exists a constant E.M.F., a discharge of current to the dynamo takes place, and the latter, acting as a motor, adds its power to that of the prime mover. One of the features of the De Poorter system is that the current supplied by the accumulators is limited to that absolutely necessary. The discharge current increases the excitation of the dynamo, and reduces the difference of potential at the brushes, thus restricting the discharge from the battery. As the speed of the engine increases, the voltage at the brushes rises, sending a charge to the accumulators and at the same time reducing the dynamo excitation. In practice, the running of the car is a constant series of changes in the character of the electrical machine, which at one moment is running as a generator and the next as a motor, the changes all taking place automatically and independently of any action on the part of the driver. The system is exceedingly simple, and, as compared with an ordinary petrol car, not only enables the usual change-speed gear to be dispensed with, but permits the engine to be started from the seat by means of the battery, which also furnishes current for the lighting of the vehicle. Three models are being made—10-12 H.P., 16-20 H.P., and 30-40 H.P.; in the first the engine is of the two-cylinder type, and in the others four-cylinder. The list price of the 16-20-H.P. chassis—that is, everything except the carriage body—is £460.

The Ampere Petrol Cars with Electrically-Controlled Transmission.—There are a number of novel features in the petrol cars made by the Société des Etablissements "Ampere," of 30, Rue du Point-du-Jour, Billancourt, France. So far as the general outline of the vehicle is concerned, this follows what may be termed standard lines—viz., a 10-16-H.P. four-cylinder engine, fixed under a bonnet

in the fore-part of the frame, a gear box at about the centre of the latter, and a cardan shaft, which drives the rear axle through bevel gearing. There, however, the similarity ends, for the ordinary change-speed lever, the clutch and the differential gear are conspicuous by their absence, their functions being effected electrically by the method described below.

Fig. 23 gives a sectional view of the gear box—the pinions of which are always in mesh—giving three speeds forward and a

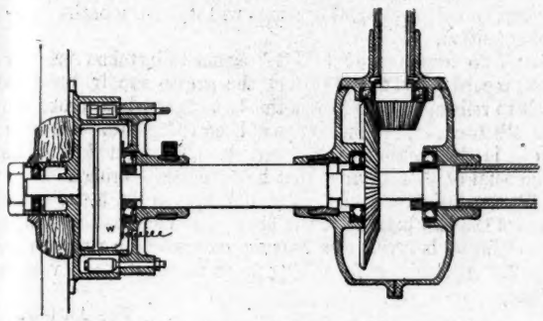


FIG. 22.—REAR AXLE, SHOWING ELECTRO-MAGNETIC CLUTCH, AMPERE CAR.

reverse, with a direct drive on the top speed. Mounted on the main shaft in such a way that while they are free to move laterally, while always rotating therewith, are four disks, each forming one-half of a magnetic clutch, the other portion of which is connected up with one of the pinions C O G J. The various speeds are brought into action by means of a switch on the steering wheel. The first speed is obtained by passing a current through the clutch A, the disk, free to slide, being then attracted to B, and the power transmitted through the pinions C D, and thence through the spur wheels I J, which convey it to the cardan shaft; similarly, the second speed is got by the clutch E F and the pinions G H; the third speed is secured by connecting up the clutch K L when the drive is direct from the engine to the cardan shaft. For the reverse motion the clutch M N is engaged, the transmission then taking place through the pinion O, an intermediary wheel not shown, and the gear wheel P.

The feature of the rear live axle (fig. 22) is that it is solid throughout instead of being built up as usual of two halves. As already mentioned, there is no mechanical differential gear, its place being taken by two electro-magnetic clutches W, one at each end. When the car is travelling along a straight road, both clutches are engaged, and the drive is transmitted to both road wheels.

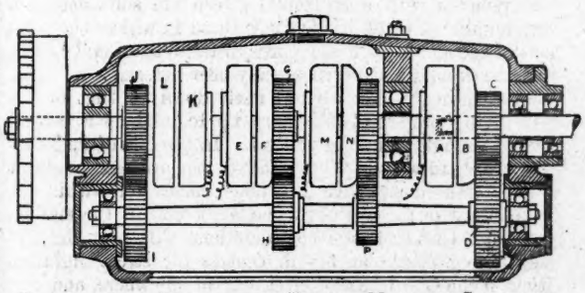


FIG. 23.—GEAR BOX, SHOWING ELECTRO-MAGNETIC CLUTCHES, AMPERE CAR.

When any turn is made, one or other of the clutches is automatically disengaged, so allowing the corresponding road wheel to run free. Thus, on turning the steering wheel to the right, the current to the right hand clutch is cut off, and *vice versâ*, the outer wheel on the curve always driving and the other running free, while by a movement of the switch or when the brakes are applied, the drive to both is interrupted, so rendering the usual clutch unnecessary, and reducing the tendency to skid. The makers claim that the two disks of the clutches are instantly connected or disconnected as the switch is moved from one point to the other.

The necessary current is furnished by a special design of magneto, driven by the engine and adapted to give two low-tension currents of different voltages—one being employed for the ignition of the explosive charge in the engine, and the other for the electrical control of the change-speed gear, for the driving of the rear road wheels, and for the lighting of the vehicle.

The arrangement adopted in the Ampere car is undoubtedly novel, and if it gives the results in practice which the makers claim, it will certainly mark a step forward in the direction of simplicity in design and construction. We may add that the price of the 10—16 H.P. chassis is £280.

The "Energy Car."—While not coming under the classification of automobiles, the productions of the Société Française de l'Energy-Car, of 81, Rue St. Lazare, Paris, are interesting as showing one of the outcomes of the combination of the modern petrol engine with a dynamo to produce a portable electricity generating unit, which can be utilised for power or lighting purposes at any desired point.

As will be seen from fig. 24, the Energy car consists of a horse-drawn vehicle, on the rear of the platform of which are mounted a petrol engine and a dynamo, the connection between the two being made by a flexible coupling, which can also act as a driving pulley. Forward of the generating set, and enclosed in a receptacle on the right of the van body, is a small battery of accumulators maintained in constant connection with the dynamo. On the other side of the body is a switchboard, on which are mounted volt and ammeters, starting rheostats, &c. The arrangement of the plant is such that when the normal power of the engine and dynamo is required, the battery is in a state of equilibrium; that is to say, it is neither being charged or being discharged. When extra power is needed, and the dynamo tends to slow down in speed, the accumulators furnish sufficient current to the generator to maintain the engine at a constant speed. On the other hand, when the load diminishes and the petrol motor commences to "race," the excess current generated by the dynamo is transmitted to the battery, the whole of these operations taking place automatically. Only two levers are employed to control the machine, the starting rheostat and the petrol tap, the employment of a battery of accumulators also enabling the engine to be started without the usual handle.

For power purposes, the Energy car can either drive any machine direct by belt or a series of machines equipped with electric motors, while it can simultaneously be employed for lighting purposes, enabling work to be carried on at night. The plant is particularly

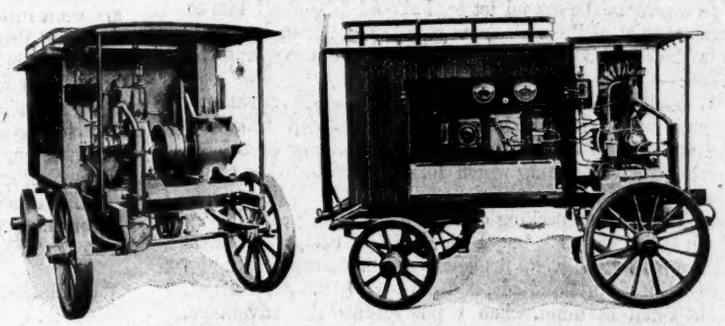


FIG. 24.—TWO VIEWS OF THE ENERGY PORTABLE POWER CAR.

well adapted for agricultural and military purposes; it is also being recommended for use in travelling cinematograph shows.

Two sizes are at present being made—6-12 H.P. and 12-24 H.P. The smaller figures denote the normal capacity of the engine, and the larger the maximum power which the plant may momentarily develop. The 6-12-H.P. plant weighs, complete in running order, with tools, petrol and lubricating oil, &c., 34 cwt., so that it can be hauled by a single horse, as compared with the three or four animals required for a portable steam engine and boiler of similar capacity. The dynamo has a capacity of 3,500 watts at 65 volts and 1,300 R.P.M.; that of the battery is 60 amp.-hours for five hours. The 12-24-H.P. plant weighs 48 cwt., the dynamo furnishing 7,200 watts at 110 volts and 1,200 R.P.M. The prices are respectively £280 and £480.

We may add that the company are at present engaged in designing an automobile plant on similar lines, in which the power generated will be transmitted to two electric motors connected to the rear road-wheels, and capable of driving the vehicle at a speed of from 6 to 7½ miles per hour.

In concluding our reference to the interesting electrical exhibits at the recent Paris Motor-Car Show, attention may be drawn to the varying views with regard to publicity taken up by the different firms. While a few have furnished us with very full details and drawings of their respective vehicles, others have confined the information afforded to mere generalities, even the type of accumulator, dynamo or motor, as the case may be, being in some cases withheld—hence the varying lengths of the foregoing descriptions.

British Enterprise in Moscow.—It is reported in German newspapers that the city of Moscow has just concluded negotiations with foreign firms in regard to the establishment of new tramways. The firm of BRUCE PEEBLES & CO., it is said, has undertaken to construct new lines and take over as equivalent value bonds to be issued by the city to the extent of 1,500,000 roubles (£150,000). The banking group closely associated with the firm, including Parr's Bank of London, will accept the obligations or bonds on the basis of 9,000,000 roubles in 5 per cents. at the price of 85 per cent., and the remaining 6,000,000 roubles in 4 per cents. at 70 per cent.

CORRESPONDENCE.

Letters received by us after **5 p.m. on Tuesday** *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

The Use of Ball Bearings on Electric Motors.

With reference to the two letters appearing in your last issue *re* the above, there are one or two points I would like to answer. In answer to Messrs. Ludw. Loewe & Co.'s letter, I should like to say that, personally, I still prefer the second type of ball bearing, and judging from the following quotation from their catalogue:—"The D.W.M. ball bearing, with its individual spring separator, is too well known to need description, but a number of our clients expressed the desire for a bearing having a solid ball separator, therefore we have placed on the market an alternative type"—I am not alone in this preference, while, again quoting their catalogue, one of the several advantages claimed for the solid ball separator is that "there are no springs to weaken," but I am quite willing to admit that there is a good deal of truth in their statement that the drawback to the first type is more imaginary than real. With regard to the second point they raise, *re* thrust, I think this bears out the first paragraphs on page 76, where I stated that about 90 per cent. of the motors manufactured did not need a thrust bearing.

In answer to the second letter, I should first of all like to thank "S. M. G." for his friendly criticism; and, secondly, to make a few remarks with regard to the points he raises:—

1. Saving in cost of packing was not the advantage claimed under No. 1 heading, but decreased length of machine (a very useful advantage); the saving in cost of packing was something which followed owing to the above advantage. I must admit that there is truth in his remark that the saving on packing cases of small machines is hardly worth thinking about, but I think 2d. is cutting it rather fine, also I know several firms who manufacture machines up to 10 B.H.P. in hundreds, and up to 25 B.H.P. in fifties. What I had in mind, when I put forward this advantage, was not so much the saving in the packing cases as the saving which would follow from this, namely, in shipping charges, for where a firm has a large foreign connection, I think this would mean a considerable saving, as most shipping lines, I believe, charge rather by bulk than weight. To quote an instance, a 5-B.H.P. at 480 revs. motor, fitted with ball bearings, required a case 2 ft. 7 in. × 2 ft. 6 in. × 2 ft. 9 in. = 17·75 cb. ft., while the same machine with ordinary bearings required a case 3 ft. 6 in. × 2 ft. 6 in. × 2 ft. 9 in. = 24 cb. ft.—a saving of 6¼ cb. ft., roughly, 25 per cent.

2. As the smallest air-gap on induction motors is about ·025 in., and shafts are usually calculated with an allowable deflection of one-tenth the air-gap, this means at least ·0025, so that the possible total extra ·0002 movement due to inaccuracies in the balls would not be very appreciable. (In passing, I would remark that the figures he has quoted are incorrect.)

3. I am afraid my wording is rather at fault here; of course, it was not intended to mean that brackets were set out and drilled $\frac{1}{100}$ in. out of centre, but when the right centre is found, the brackets are then steady pinned to the stator, this giving the effect of the bracket being eccentric to the stator core.

This idea is also used on large open-type machines where it is thought advisable to relieve the bearing as much as possible by dropping the magnet slightly, by having less liners under the magnet than the bearing pedestals.

4. I think I pointed out that great improvements have been made in oil flingers in recent years, and with regard to heating, it should be borne in mind that if a ball bearing is heating, the odds are that it is overloaded, provided it has a supply of grease. With cups fitted as shown in the various sketches, I have never experienced any trouble with the grease escaping.

5. I did not say that 1 per cent. better efficiency was the best obtainable, but quoted 1 per cent. as an example, and with regard to the special shaft, end caps, &c., the idea throughout the article was that ball-bearing machines should be made as standard machines, in batches, and not in isolated cases.

6. Instead of machining the bracket after the centre is found, it is far simpler and cheaper to find the centre and then to make the length of the spacing tube between the thrust and journal bearing to suit.

7. I do not think there is any need for a ball-bearing expert, as well-made ball bearings will run for months without attention.

8. I do not suppose "S.M.G." means to be taken seriously with regard to fig. 2 ? (11) and the grease supply, but it is well to remember that it was the last straw which broke the camel's back, and in these days of keen competition it is only on little things that saving may be effected, and it is the sum total of these savings that helps to secure orders.

In conclusion, I would point out that in fig. 5 the outer race of the ball bearing in the brush-gear end bearing should be clamped between the bearing covers and a ring, as in fig. 7. Apologising for taking up so much of your valued space,

The Author.

The City Lighting and Measurement of Illumination.

I have nothing to add to the able remarks of Mr. Kenelm Edgcumbe and of Mr. Roger T. Smith on the necessity of measuring illumination on a horizontal plane in the cases with which they deal.

My work in illumination photometry in association with Sir William Preece in 1884 was carried out with his photometers held in the hand, or mounted on stands about 4 ft. from the ground. My work in 1892 was done with photometer screens about 6 in. from the ground (I prefer not to be too close to a photometer). The work of Mr. H. Fowler and the recent work of Mr. K. Edgcumbe and others, and the recent measurements by Mr. Roger T. Smith lead me to think that a height of 4 ft. from the ground is best.

I am now engaged in re-writing the paper to which Mr. Roger T. Smith kindly alludes.

A. P. Trotter.

Westminster, *January 17th.*

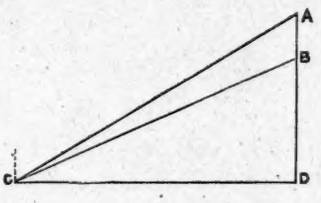
I think that all engineers interested in the subject of illumination will welcome Mr. Roger T. Smith's suggestions to the effect that methods of measuring illumination values should be standardised, and will also agree with him that measurements with a horizontal screen are sufficient in a large number of cases, particularly those in which the positions of the lamps, both as regards distance apart and height from the ground line, have already been determined. The comparison in this case narrows itself down to that of the light-giving properties of a lamp up to, and at a certain maximum angle from, the vertical. In the case of Paddington Station, to which we are referred, the greatest angle at which measurements have been taken comes well within the range of any of the inclined flame lamps now in the market, but I fear that economic considerations will not admit of lamps being placed at 30-yd. centres for street lighting, either in the City of London streets or elsewhere, and this being the case, this subject needs a wider consideration than can be given to it if we agree to take our measurements only according to Mr. Trotter's original method.

To show how we can be misled by taking horizontal measurements only, I will take the case of two different types of flame lamp, one of which is capable of giving a high candle-power at a greater angle from the vertical than the other, and I will show that in this case the illumination measured on a vertical plane is a powerful factor in the comparison.

Suppose we take two lamps, one of which (A, p. 133) requires to be hung at a greater elevation than the other one (B) in order to give the same horizontal illumination at a point (C) at a given distance from the point of support (D), and for examples of such lamps we may take the inclined-carbon lamp which gives its maximum candle-power at an angle of 30° to 40° as (A), and the vertical-carbon Crompton-Blondel lamp as described in your issue of December 29th, 1907, which has its maximum at an angle of about 70° as (B). Then it is

obvious that the lamp (B) will have the greater utility for street lighting than the lamp (A), because while it may be only equal to the other for horizontally measured illumination, it is superior to it for illumination measured on a vertical surface, and I would like to point out that this illumination of vertical surfaces is of the greatest value, for a street always appears to be brighter and better lighted if a good illumination is given to walls of buildings and sides of obstacles, passing vehicles and foot passengers; indeed, it can almost be said that from a spectacular point of view it is of more importance than the horizontal illumination measured as if on the surface of the road.

Before coming to a decision as to methods of comparing systems of lighting, we should fully realise this point and make due allowance for it. Mr. Haydn Harrison's systems of direct measurement and 45° measurement meet the case to some extent, but they do not go far enough. We should take our horizontal measurements either on the ground or at



a height of 4 ft., as Mr. Roger T. Smith suggests, preferably the latter, but we should also take vertical readings at each point, as well as a series of vertical readings at various heights above ground level in a few places, and particularly at the point of minimum horizontal illumination if it is decided to take minimum illumination figures as our basis for making comparisons between different street-lighting systems.

In connection with this discussion, an editorial article in the *Electrical World* of New York for January 4th, 1908, will be found of some considerable interest. It points out that although the inclined-carbon lamp has been most successful in America for advertising purposes, lighting shop fronts, &c., it has not met with a great deal of success for ordinary street lighting, and it gives as the principal reason for this the fact that so much of the light is thrown downwards. If we put this in another way, it means that this type of lamp has to be hung at such a height that too much of the illumination is given to the surface of the road and too little to the illumination of vertical surfaces.

Allan Williams.

London, E.C., *January 20th*, 1908.

Production of Energy from Peat.

Mr. Erith, in a letter under the above heading which appeared in your issue on January 10th, renews the attack upon me.

I dislike this sort of controversy intensely, and shall confine my reply to the analysis of one paragraph of his letter, though I shall quote two; these are:—

"Mr. Tomlinson shows that if half the total heat of the fuel is available for drying in the form of warm jacket water and exhaust gases, then 4,322 B.TH.U. will be available to evaporate 1½ lb. moisture, theoretically requiring 1,650 B.TH.U., which is 36 per cent. efficiency."

"But, as Mr. Sturgeon shows, the gas produced by 1 lb. of 8,644 B.TH.U. chemically dry peat is only 5,825 B.TH.U., so the heat loss in the producer is 33 per cent.; and if the gas engine had the proposed thermal efficiency of 30 per cent., it is clear that only 37 per cent. = 3,198 B.TH.U. could remain in the warm jacket water and exhaust gases, when the dryer would have to have 51 per cent. efficiency."

The former gives my figures correctly, and these are and were the figures attacked. I added: "This heat properly applied is quite adequate to the duty." I see no reason to alter this opinion.

The latter is Mr. Erith's rejoinder, and can be readily shown to be wrong in the facts assumed and hopelessly wrong in the deductions—even if the facts were right.

Mr. Sturgeon stated in his letter published in the Review of January 3rd, "1 ton of air-dried peat produced 87,000 cb. ft. of gas of a calorific value of 150 B.TH.U. per cb. ft. = 5,825 B.TH.U. per lb." Mr. Erith changed Mr. Sturgeon's "air-dried" into "chemically-dry," and so started off with a wrong figure; he next assumed that the figure 8,644, which I gave as the thermal value per pound of chemically-dry peat from a particular bog, applied to the particular experiment cited by Mr. Sturgeon, and so got an assumed figure. From these he gets a figure, 33 per cent., which he takes to represent the percentage loss in the producer. This is his first wrong deduction. As a matter of fact, it is readily deducible, from figures given in my address, as 25 per cent.; these figures were given to me by an expert in producer work on the actual analysis of the peat proposed to be used and under the proposed conditions of working.

The second wrong deduction is still more curious. Having wrongly taken Mr. Sturgeon's figure 5,825 B.TH.U. as giving the B.TH.U. realised per pound of chemically-dry peat, Mr. Erith, had he been content with a mere working consistency in error, would have proceeded as follows:—This 5,825 B.TH.U. if utilised in a gas engine with 30 per cent. thermal efficiency would give in the exhaust and cooling water 70 per cent. of 5,825 = 4,078 B.TH.U. The figure would have been wrong, because based on an initial error, but it would not have been absurd.

Instead, however, of proceeding thus, he embarks on another curious arithmetical operation. He adds the 33 per cent., wrongly calculated as lost in the producer, to the 30 per cent. thermal efficiency of the engine, and then triumphantly deduces "it is clear that only 37 per cent. = 3,198 B.TH.U. could remain in the warm jacket water and exhaust gases." This is the second wrong deduction.

I shall not be so discourteous to Mr. Erith as to say that he designedly misquoted Mr. Sturgeon's figure, nor that he is ignorant of the fact that the thermal efficiency of an engine is the heat utilised divided by the heat delivered (which makes the efficiency in his case $\frac{30}{67}$ = 44 per cent., not 30 per cent.); but shall assume that mere carelessness has packed a seven-line paragraph record-full of inaccuracies; but this carelessness so simulates mere ignorance and incapacity in its results that Mr. Erith has run a grave risk of the less charitable interpretation; and, at any rate, a man who starts a controversy owes it as a courtesy to the journal which lends him its columns, to those whose opinions he challenges, and to his possible readers, to give the best he can.

As the result of my examination of this paragraph and of the insight thereby obtained into Mr. Erith's methods of working, I am not greatly concerned as to what his opinion on the wider question, or any branch of it, may be.

The remainder of his letter could readily be subjected to an equally destructive commentary if it were worth while.

Thomas Tomlinson.

Dublin, *January 20th*, 1908.

Lighting of Westminster Abbey.

I was pleased to see the article on the above subject by Mr. Chas. A. Baker in the current issue of the Review, having been myself particularly struck with the inefficiency of the lighting of the Abbey whilst attending the funeral of Lord Kelvin.

In my opinion, however, I do not think the question of lighting is the greatest argument for an alteration in this state of affairs, but rather the extreme importance of securing for so valuable an edifice the *safest* means of lighting.

It is most essential that a building of this kind, having such an enormous national value, should not be permitted to retain so dangerous a means of lighting as gas in any form whatever.

I should prefer to carry out the lighting by means of electric candles adapted to some of the old fittings already in position, notably those in Edward the Confessor's Chapel, but only provided the conduit work could be effectively concealed; but standards might be adopted with advantage

where the wiring could be laid beneath the stone floor with suitable inspection points.

The unique position that electricity holds in its adaptability to the oldest designs of fittings, &c., shows us how easy it would become to effectively light the Abbey without destroying the ancient character of the place.

J. P. Strange.

Tunbridge Wells, *January 18th*, 1908.

Unadvertised Appointments.

May I draw your attention to the "Personal" Column of the *Electrical Engineer* for December 20th, 1907?

Therein I observe that Mr. W. E. Ireland is promoted to a position on the L.C.C. worth £400 per annum.

Surely this condition of municipal partiality should not be tolerated. If a position worth £400 is vacant in any public undertaking, the ratepayers have a right to demand that the position should be occupied by the best man it is possible to secure.

I venture to say that this result can only be obtained by giving, through the Press, full publicity that the position is vacant.

Wimbledon.

Institution of Copper and Brass Manufacturers.

There has been for many years a felt want among progressive manufacturers for an institution of a similar kind to that valuable organisation possessed by the iron and steel traders.

The effect of such institutions cannot be overestimated, and there is no need to enlarge upon the many advantages to be gained from them. The object of my letter to you, Sirs, is to put the question of the establishment of an institution of copper and brass manufacturers through the medium of your paper, and to find out the views of those interested as to the advisability of such a step.

Walter H. A. Robertson.

Bedford, *January 20th*, 1908.

Heat-Dissipating Varnishes.

Every now and then the technical Press publishes an article on this subject, but I regret to say that I have not yet seen one that puts the matter in a clear and scientific light. The word "dissipating" appears to be the pitfall, as it leads to a confusion between the ideas of conduction and radiation. Everyone knows that the two phenomena are quite distinct, so there is no need to elaborate the point.

Turning now to the article by Mr. A. R. Warnes, published in your issue of January 17th, we find an account of some experiments on the *radiating* properties of some "white" varnishes. Seeing that these varnishes are designed to act as heat *conductors* between wires, these tests are of little practical value. From the heat-dissipating point of view, the ideal treatment for a coil would be:—(1) To provide a mineral-filled varnish of good heat conductivity which would completely fill the interspaces of the winding, and would conduct the heat to the coolest point, *i.e.*, the surface; (2) to keep the surface cool by providing a good radiating coat of dull-black varnish. For this purpose lamp-black and turpentine would be just the thing, but in practical work we need a finishing varnish that will insulate, and that will have a smoothly polished coat that cannot collect dust and dirt. A sacrifice of heat-radiating properties is thus forced upon us, just as in the interior of the coil we must be content with less conductivity in our varnish in order to keep up the insulating and mechanical qualities.

In conclusion, we must recognise that a material that will conduct well is very likely to be a poor radiator, and *vice versa*. It is a case where it is better not to kill two birds with one stone, but to take one to each. We want a heat-conducting varnish to saturate the winding, especially with round wires. We also want a good finishing varnish that will have as high a radiating power as possible, consistent with smooth surface and first-class insulation.

J. S. S. Cooper, M.A., B.Sc.

Trafford Park, Manchester.
January 20th, 1908.

Test of an Ozoniser.

We have read with interest the account you give of the test of an ozoniser in your issue of January 17th, but although the account states that the test should be made for different concentrations, yet we are not able to find that these have actually been stated, although other particulars of the test are given.

That this is of paramount importance can be gathered from the fact that some of our types of ozone generators will give as high a yield as 500 gm. per kilowatt-hour at the low concentration necessary for ventilation purposes.

One of the most, if not the most important part of the test has, however, been overlooked in the description. We refer, of course, to the test for nitrogen compounds. It is highly essential that any ozone apparatus to be used for ventilating or therapeutic purposes should be designed so that absolutely no trace of the compounds of nitrogen be generated. This is a point which is more often than not overlooked by those purchasing this class of apparatus.

We have lately made a series of elaborate tests with a great many types of so-called ozonisers, and they, every one of them, more or less, gave off compounds of nitrogen in varying proportion. The best of them generated about 500 per cent. more nitrogen compounds than ozone; you can imagine what the worst was like.

No test of an ozoniser is complete without this test for nitrogen compounds, more especially if it is to be used in ventilation.

Ozonair, Ltd.,
Edward L. Joseph, *Managing Director.*

London, W.C., *January 20th*, 1908.

Several letters have been received too late for insertion, and are held over to our next issue.—Eds. E.R.

LEGAL.

Brown *v.* Herald Manufacturing Co., Ltd.

At the Preston Sheriff's Court, on Wednesday, January 15th, Arthur George Brown, electrical engineer, King Street West, Manchester, claimed from the Herald Manufacturing Co., Ltd., £552 12s., value of goods seized under a distraint for rent, and damage. The case had been remitted from the High Court. Defendants were not present and were not represented. Mr. W. H. Shawcross stated that for several years prior to May 4th, 1906, the defendants were lessees of premises owned by Mr. John Renton in King Street West, and plaintiff was a sub-tenant of two large rooms under the defendant company. In these rooms plaintiff had stored a large quantity of electrical appliances, machinery, &c, used in his business. On May 4th the defendant company owed to Mr. Renton a considerable sum for rent, and the landlord distrained. He took all the goods on the premises, with the result that plaintiff's property to the amount of £552 was seized. Plaintiff intimated that, in addition to the value of the goods, his business had suffered to the extent of £500 or £600. Mr. Renton stated that the amount of rent owing was £265; the goods seized only realised £81 8s. The Jury assessed the damages at £752 10s.

Sanderson *v.* Pearson.

In our report of this case in our last issue (page 92) we stated that judgment had been given for the *plaintiff*. This was an error. Judgment was given for the *defendant*.

Westminster Electric Supply Corporation *v.* London County Council.

On Thursday, January 16th, Mr. Justice Phillimore and Mr. Justice Walton, sitting as a Divisional Court in the King's Bench Division, had before them this case, on plaintiffs' appeal from the judgment of the County Court Judge of Westminster.

Mr. A. B. Shaw appeared for plaintiffs, and Mr. Horace Avory, K.C., and Mr. Radcliffe Cousins were for the defendant Council.

In presenting plaintiffs' case, Mr. Shaw explained that the action was brought to recover damages alleged to have been caused by the Council's servants to their electric cables in the borough of Westminster. In October the plaintiffs had some trouble with their cable, a short-circuit manifesting itself. They traced it to Greycoat Place, Westminster, where in the previous February the defendant Council had erected a fire station, and on opening the ground they found that the casing had been injured, letting in damp and thus eventually destroying the insulation. When the action came before the County Court Judge the defendant Council pleaded the Public Authorities Protection Act, maintaining that, inasmuch as the writ was not issued within six months of the cause of action, the plaintiffs had waived their right of action. He (Counsel), however, maintained that the defendants were by their own conduct precluded from relying upon the statute, for it was at the written request of their own superintendent architect that the plaintiffs allowed the matter to stand in abeyance till after the next committee meeting, thus delaying the issue of the writ. He quoted authorities in support of this contention, and argued that the County Court Judge was wrong in holding that there had been a waiver by reason of the delay.

Mr. Horace Avory, K.C., denied that the County Council had done anything which precluded them from pleading the Public Authorities Protection Act, pointing out that all the superintendent architect wrote was that he presumed legal proceedings would not be taken.

Their Lordships held that the superintendent architect had not actually requested the delay in the issue of the writ, and dismissed the appeal with costs.

Heath and others *v.* The Brighton Corporation.

In the Chancery Division of the High Court of Justice, on Thursday, January 16th, Mr. Justice Joyce commenced the hearing of an action brought by the Rev. Edward Heath, Colonel Grove-Morris, and Mr. Frank Harold Leary for an injunction restraining the Brighton Corporation from working their electrical plant in North Road works and extension so as to cause nuisance and annoyance to the worshippers in the Church of Saints Mary and Mary Magdalene, Bread Street, Brighton, and to the persons using the class-rooms belonging thereto.

Plaintiffs alleged that the noise from the machinery disturbed and hindered the Rev. Heath in his conduct of divine service, and rendered it difficult, and at times impossible, to hold classes and meetings.

The Corporation pleaded that their machinery was of the best modern type, was carefully run, and was housed in a building specially designed and completely suitable for the purpose. They denied the alleged nuisance and inconvenience, and relied upon their statutory powers, which, they claimed, they had exercised in a reasonable and proper manner.

Mr. Hughes, K.C., for the plaintiffs, said his clients were the trustees of the church and buildings.

His Lordship asked if noise only was complained of.

Mr. Astbury, K.C. (for the Corporation): A noise you cannot hear.

Mr. Hughes said that the nuisance was still intolerable, despite the efforts of the Corporation to reduce the noise, which was of a very unpleasant humming or buzzing character.

The learned Counsel had not concluded his address at the rising of the Court.

The hearing was continued on Friday and Saturday. The Rev. Mr. Heath, in his evidence, described the noise in the church as a nuisance. It interfered with the conducting of the public worship and also the work in the class-rooms connected with the church building. Sometimes the noise from the electrical works could be heard above the organ and choir.

Mr. Dinnock, agent for property in Bread Street, stated that since the erection of the electrical works, the letting value of the property had deteriorated.

His Lordship continued the hearing of the case on Tuesday.

Prof. Wilson, consulting engineer, Westminster, gave evidence as to having inspected the church and the corporation works at Brighton, in June and July last. He supported the plaintiffs' claim as to the noise which the electricity works created.

Other evidence as to nuisance having been given, the hearing was again adjourned.

The Late Sir John Pender and the Supply of Electricity to Rome.

On Tuesday, in the King's Bench Division of the High Court, Mr. Justice Grantham and a special jury had before them the case of Girolame Taddei and Paoli Bellami, two Italian engineers, against John D. Pender, Lord Hay, and Richard Enfield, executors of the late Sir John Pender, for breach of contract made in December, 1889, between the plaintiffs and Sir John Pender on the one part and Mr. Jabez S. Balfour on the other part, whereby it was agreed to purchase from the plaintiffs certain water rights and concessions in Italy for the purpose of generating electricity for the lighting of the City of Rome and other uses. Defendants denied that they were in default, and said that the agreement was not actually made.

Mr. Horridge, K.C., M.P., and Mr. C. C. Scott appeared for the plaintiffs, and Sir Edward Carson, K.C., M.P., Mr. Rufus Isaacs, K.C., M.P., and Mr. Spencer Bower, K.C., were for the defendants.

Mr. Horridge, in opening the case, said plaintiffs were two Italian gentlemen, and the transactions of which the case formed the subject took place in 1889, and they had reference to property in a district some 17 miles from the city of Rome. About this time a villa was owned by Cardinal Prince Hohenlohe. He was living as a tenant of the property, but he had the power of selling it subject to the consent of the Royal House in Austria. At this time the eyes of engineers in England were turned towards Italy for the exploiting of electrical energy, electrical power and electric light, and he thought they would agree that the plaintiffs held a considerable position with regard to electrical energy and with regards to works of electrical engineering skill. In 1889 it occurred to them that a scheme could be inaugurated for using the water-power at the villa near Rome, known as D'Este, for the purpose of supplying electrical power to the City of Rome. A scheme was conceived by the plaintiffs, and this they were anxious to carry out, but a difficulty arose in this way—the Cardinal, who owned the property, could not sell the water rights unless the whole estate was sold as well. There was also a gentleman called a Mr. Deldecchel who took an interest in educational questions, and he joined them, and the question of an educational college was mentioned. Plaintiffs came to England and saw Sir John Pender, who was interested in electrical enterprises, being chairman of the Eastern Extension Telegraph Co. He had in Rome a gentleman called Mr. Mackenzie, and he had acted as technical agent with regard to several enterprises. Mr. Bellami was agent in Italy for the Thomson-Houston Atlantic Co., and they would also be satisfied that Mr. Laddei had supplied electric light to leading houses in Italy. When they saw Sir John Pender in England he was favourably impressed with regard to the scheme, and said he was anxious to form a company for gentlemen exploiting electricity in Italy, and he proposed to call the company The Italian General Works Electrical Enterprise Co. Plaintiffs were instructed to go back to Italy to see if they could arrange the matter, the result being that they entered into an agreement—and sent it to Sir John Pender and his advisers—by which they agreed to purchase from the Prince Cardinal their right to use water for 600,000 lire (£24,000). They also arranged for the sale of the National Educational College, in the Villa of D'Este for 450,000 fr. (£18,000), and both those agreements were entered into and completed. Plaintiffs paid to the Cardinal a deposit of £2,000 for the water rights, and they guaranteed to the Cardinal payment of another £2 000 as against the completion by the purchasers of the Educational College.

Sir John Pender wished to have associated with him Jabez S. Balfour. When the property came to be bought out £100,000 was to be paid for it, plaintiffs to receive £68,000, £25,000 to be kept by Sir John Pender, and £7,000 to be paid to Mr. Mackenzie for what he did in connection with the matter. It was necessary, in the first instance, to get the purchase completed in order to go to the Government to obtain what was known as the decree of public utility. There was at that time a rival company in Rome called the Romana Gas Co., and the jury would find that there was a good deal in the correspondence which had reference to plaintiffs' inability to complete the agreement, but it was pointed out by the plaintiffs that the exact position of this company was known to Sir John Pender, as he had instructed a gentleman named Oswald Brown to go out to Rome to inquire into everything and report to him, which he did.

Counsel then read correspondence at length, in which it transpired that the agreement fell through, and the concessions for the generation of electricity were never obtained.

(To be continued.)

W. Griffiths & Co. *v.* Middlesex County Council.

In the King's Bench Division of the High Court on Friday Mr. Justice Channell had this case before him. Plaintiffs are contractors for the construction of electric tramway lines, and they brought their action in connection with a contract for the construction of 9¾ miles of tramway in North London.

Mr. Clavell Salter, K.C., M.P., and Mr. J. H. Simon, M.P., were for the plaintiffs; and Mr. English Harrison, K.C., Mr. Harper and Mr. Eustace Hills appeared for the defendants.

Mr. Salter said the facts of the case were that there was a contract between the plaintiffs, who were tramway contractors, and the defendants, for the construction of a light railway or electric tramway line, starting from Highgate and running north. The contract provided that the contractors were to do the work, starting when they were told by the defendants. When they got the order to start they were bound to finish in six months from that date. When plaintiffs did commence the work it was found that all the usual arrangements and adjustments had not been made, and in consequence a series of delays began, with the result that instead of starting on February 11th, 1903, the plaintiffs were obliged to wait until 30 days within the time the work ought to have been completed. Consequently the plaintiffs were unable to complete the work until August 5th of the following year. The entire work was thus disorganised and altered, and instead of it being a summer job it was turned into a summer and winter job, causing a loss to the contractors, the plaintiffs, of something like £10,000. Plaintiffs brought their action, alleging in substance that there was in a contract of that kind a duty on the part of the employers, the defendants, of co-operation to facilitate the work in reason. That was the duty plaintiffs alleged defendants had not carried out, and they had sustained damage in consequence.

His Lordship: The real question is whether it was an implied term of the contract that when the order should be given the work should not commence until the defendants should secure that all reasonable obstructions should be removed.

Mr. Salter said that defendants alleged that there was no such implied term. Subsequently the matter went to arbitration, in connection with which there was a difference between the parties. Mr. Harris, civil engineer, was appointed arbitrator, but just before the close of the proceedings the arbitrator appeared to have been requested by both parties to postpone the consideration of one part of the contract. Some correspondence between the arbitrator and the parties took place, and he eventually made his award in favour of the County Council.

Counsel (continuing) said this electric tramway was worked on the overhead system. The overhead wires were supported by standards, which were sometimes at the side and sometimes between the two lines. Obviously, whether one system or the other was adopted it affected the construction of the whole system. In the present case the question whether the standards were to be in the middle or at the side of the lines was to be settled between the defendants and the persons who were the highway authorities. They differed on this question. This caused some delay, and, therefore, there was an onus thrown upon the defendants. The contract, he believed, was to have the standards at the side, but the defendants came forward and said they must have centre standards. There was an arbitration in connection with the matter, and it was agreed to have the standards in the centre. This caused delay, and resulted in a loss to the contractors.

The hearing was continued before his Lordship on Saturday, when Mr. English Harrison, K.C., for the defence, argued that there was no implied contract as alleged.

His Lordship said he had only to deal with certain issues in the case, but as to the contract he did not think he could give a judgment which would be of any value at present. As to the question as to whether the plaintiffs had a right of action, he gave his judgment for the plaintiffs, holding that to say there had been an arbitration, and that it had lapsed, was no answer. As to the contract part, he would read the papers over, and give his opinion later.

Commercial Electro-Chemical Analysis Co., Ltd., *v.* The X Electric Accumulator Co., Ltd.

In the City of London Court on Tuesday, before Judge Rentoul, K.C., the plaintiffs, of 15, Queen Street, E.C., sued the defendants, of 18, Leadenhall Street, E.C., to recover four guineas for making an analysis of oil of vitriol and fees for consultations in connection therewith.

Mr. A. M. Longhurst appeared for the plaintiffs, and Mr. McCanna for the defendants.

Mr. E. B. Vaughan, secretary of the plaintiff company, said he was a Fellow of the Chemical Society, and he had other diplomas. The plaintiff company was claiming £1 11s. 6d. for making a qualitative analysis of a sample of oil of vitriol for the defendants, who wanted to see what quantities of iron and ammonia were contained in it. They were also claiming 2½ guineas for consultations. He did not make a quantitative analysis.

Mr. McCanna said the defendants were engaged in some litigation, in which they were suing a firm of Messrs. Burke, to whom they had supplied acids, and the defendant company wanted two separate analyses made for the purpose of submitting to the Court. Mr. Matthew J. Cannon was instructed by the defendants to make one analysis, and the present plaintiffs were selected as the other firm to make the analysis. It turned out that the plaintiffs had not a chemist on their premises at the time, and they sent the matter out, oddly enough, to Mr. Cannon, who made a second analysis. Of course, the defendants had paid Mr. Cannon for the analysis which he made for them, but the plaintiffs had destroyed the purpose with which a second opinion was sought for. The defendants could not be called upon to pay the plaintiffs under those circumstances. The plaintiffs gave the defendants the total residue, but that was not enough. Mr. Cannon made a proper analysis. What the defendants wanted was separate analyses. Mr. Cannon's analysis was both quantitative and qualitative. Plaintiffs was only qualitative. Mr. Longhurst said it was both. The plaintiff company's consulting analyst was Mr. Vickery, but he had been employed by Messrs. Burke in the litigation mentioned. The plaintiffs could not possibly know that Mr. Cannon had been employed by the defendants. The plaintiffs were quite at liberty to employ whom they liked. Mr. McCanna said the defendants relied on the plaintiff company's advertisements that they could make the analysis themselves, and they did not think they would put it out. Plaintiffs had advertised that they were specialists on the matter, and defendants thought plaintiffs would themselves make the analysis. Mr. Longhurst said that was the first they had heard of that.

Judge Rentoul said the difficulty for the plaintiffs to get over was that defendants wanted two opinions and they only had one.

Mr. Longhurst: He did not tell us anything about that at the time. The plaintiff company could employ anyone they liked.

Judge Rentoul: The plaintiff company were expected to have a permanent chemist of their own.

Mr. Longhurst: They had, and that was Mr. Vickery, but we could not go to him.

Mr. Vaughan added that the plaintiff company was formed to give consultations on electricity and to make analyses. One of the consultations with the defendants took half an hour.

Mr. McCanna said he thought he was going to get an analysis made by one of the plaintiffs' staff. Mr. Vaughan was of no use to them when they got before the Judge. He offered his help and all that sort of thing. Witness consulted all sorts of big people in the profession, and Mr. Vaughan knew practically nothing about the matter. He never had any consultations with him.

Mr. Albert Tanner, one of the plaintiffs' directors, was called in support of their case. Mr. Vaughan, he considered, had rendered the defendants much material help on the technical part of the dispute.

Mr. McCanna said what was wanted to find out was whether iron was injurious to electric batteries. The whole subject touched the bedrock of the electric accumulator building business. No doubt Mr. Vaughan was very interested in the subject.

Judge Rentoul said defendants would never have sent to the plaintiffs if they had thought they were going to get Mr. Cannon's opinion. Defendants had not got any value from the analyses sued for. Plaintiffs were unfortunate, but he must find for the defendant company with costs.

BUSINESS NOTES.

British Trade with India.—In *The Chemical Trade Journal* a letter appears from "A Correspondent" concerning a rumour that "sample rooms" are to be revived again in India by enterprising persons who are desirous of rendering assistance to British trade. He writes:—"A 'sample room' is an old friend, and ought to be antiquated by now. Twenty years ago 'sample rooms' were the adjunct to local Indian newspapers, the publishers of which, in addition to advertising the goods, kept samples of them on their shelves. Likewise, agency firms, for an annual rental, would put on a shelf whatever samples were sent to them. These odd museums never secured orders, although the samples in course of time disappeared. A mere 'sample room' will no more secure orders than will the British Museum. It is the manufacturer's own salaried representative on the spot that is required. The writer knows of a British firm whose agent recently arrived in India with 10,000 free samples worth a shilling each. No sooner had he landed than enterprising 'merchants' at the first town 'bagged' the lot! One town—10,000 free samples! He returned to London a sadder, but a wiser man, without any orders."

Liquidation Proceedings. — Johnstone, Benjamin and Co., Ltd., electrical wire and cable manufacturers, 10, Ascham Street, Kentish Town.—A compulsory winding up order having been made against this company, the statutory first meeting of the creditors and shareholders was held on Friday, 17th inst., at the Carey Street offices of the Board of Trade.

Mr. H. M. Winearls, Official Receiver, presided; Mr. Colyer (Colyer & Son), Mr. Oscar Osborn (Osborn & Osborn), and Mr. Montagu attended on behalf of the creditors.

The Chairman reported that the winding up order was made on November 26th upon the petition of Messrs. C. N. Johnson & Sons, Ltd., and the Britannia Rubber and Kamptulicon Co. A statement of affairs had been prepared by Mr. B. T. Norton, the Receiver acting for the debenture-holders. It showed 71 unsecured debts amounting to £3,134 15s. 9d.; liabilities on bills, £186 15s. 8d. (not expected to rank for dividend); preferential claims for rates, taxes and wages, £126 2s. 9d.; and loans on debenture bonds, £2,845 17s. 3d., making a total indebtedness of £6,296 11s. 5d. The assets were valued at £6,232 0s. 11d., and consisted of cash at bankers, £27 5s. 9d.; cash in hand, £1 2s.; stock in trade, £797 1s. 3d. (estimated cost, £1,062 15s.); machinery, £2,000 (estimated cost, £2,835 10s.); trade fixtures, fittings, &c., £30; lease of 10, Ascham Street, Kentish Town, £740; stock in hands of Britannia Rubber Co., Ltd., £126 19s. 6d.; stock in hands of Midland Railway Co., Ltd., £42 4s. 6d.; good book debts, £2,432 2s. 6d.; doubtful and bad debts together amounting to £1,696 11s. 9d., but only estimated to produce £22 15s. 5d.; and unpaid calls, £100, valued at £12 10s. After deducting the preferential claims and the loans on debenture bonds, there remained a balance of £3,257 0s. 11d. to meet the £3,134 15s. 9d. ranking as liabilities, or, in other words, a surplus of £122 5s. 2d. after discharging all the liabilities; but that, of course, was subject to realisation. The account with the contributories disclosed a deficiency of £6,837 4s. 10d.

The company was registered on December 17th, 1900, with a nominal capital of £15,000, divided into £10,000 ordinary and £5,000 deferred shares, and was formed to take over for Lewis and Ernest Emanuel Benjamin the business they had carried on at Ascham Street. Under the purchase agreement, dated December 22nd, 1900, the consideration of £9,200, divisible equally between the vendors, was to be satisfied as to £500 in cash, £2,200 in 4½ per cent. debentures, £1,500 deferred and £5,000 ordinary shares. In addition, the vendors were to be appointed managing directors for seven years from December 20th, 1900, at £250 per annum each. Mr. E. E. Benjamin had stated that the business was originally started by him in or about 1885. He was subsequently joined by his cousin, Lewis Benjamin, and they carried on the business at Bow and at Wenlock Road, City Road. In June, 1900, it was moved to Ascham Street, a lease on the premises being then taken by them for 21 years from March 25th, 1900, at £240 per annum. It did not appear that any independent investigation as to the value of the assets acquired was made at the time of their transfer to the company. The goodwill and business were assigned to the company under a deed dated January 8th, 1901. It was not clear when the company actually went to allotment. With the exception

of one share, which was entered in the register of members as having been allotted on December 28th, 1900, there was no reference to any allotment earlier than January 5th, 1901. The debts of the business were not taken over by the company. On January 11th, 1901, proceedings in bankruptcy were commenced against the vendors, who thereupon resigned their position of managing directors, and were appointed as managers at the same salary. A receiving order was made against them on January 29th, 1901, and subsequently, under an arrangement sanctioned by the Court, a composition of 10s. in the £ was paid to their creditors, whose claims amounted to £7,480 7s. 8d. To assist the vendors to carry through the arrangement, the company advanced to them, on the security of the 6,500 shares, £1,349 12s. 10d., which still remained unpaid, and was returned in the statement of affairs as irrecoverable.

At the first meeting of directors, held on December 22nd, 1900, it was resolved that 30 first mortgage debentures of £100 each, redeemable January 1st, 1906, should be issued, and that the company's seal, and the signatures of the managing directors should be affixed to 22 of such debentures, to be handed over to them or their nominees. The 22 debentures were subsequently allotted as follows, but the date when they were actually issued, would have to be ascertained:—

To the trustees of the marriage settlement of Lewis Benjamin ..	£1,100
To the trustee of the marriage settlement of E. E. Benjamin ..	700
To E. E. Benjamin	400
	£2,200

On January 30th, 1901, Mr. E. E. Benjamin transferred the £400 debentures to Mr. A. Adams, and on August 19th, 1907, the latter, who was the trustee of E. E. Benjamin's marriage settlement, transferred £700 debentures to Mr. F. Rawlings and Mr. Joseph Benjamin. On November 19th, 1907, a debenture action was commenced, and three days later, Mr. B. T. Norton, C.A., 9, Old Jewry Chambers, E.C., was appointed as receiver and manager, and was now in possession of the company's property. The circumstances relating to the issue of the debentures would be brought before the Court in the debenture action, as they were not registered at the Joint Stock Registry in accordance with the provisions of the Companies' Act, 1900. That step was very material if the assets should not realise sufficient to pay all the debts in full. In the debenture action they would raise the question of the validity of the debentures, because if they were issued after January 1st, 1901, when the Companies' Act came into operation, they might be held to be invalid on the ground that they had not been registered. If, however, the holders of the bonds could prove that they were issued prior to that date it might be decided that the registration was not necessary. In the course of the proceedings which had taken place in connection with the debenture action, affidavits had been filed in which it was stated as a fact that some of the debentures were not issued until January, 1901. No interest had been paid on the debentures since their issue. The Official Receiver, acting as provisional liquidator, had instructed the solicitors for the petitioning creditors to enter an appearance for the company in the debenture action, so that the rights of the unsecured creditors might be safeguarded pending the appointment of a liquidator.

During the year 1901 the company traded at a profit of £757 1s. 11d., and during the following year at a profit of £320 11s. 8d. Since then a gradually-increasing loss had been made every year. Mr. Ernest E. Benjamin had stated that, in his opinion, the failure of the company was to be attributed to the high price of copper and other raw materials, insufficiency of capital and extreme foreign competition. He was entirely occupied in the manufacturing part of the business, the whole of the financial part having been under the control of Mr. Lewis Benjamin, who disappeared on November 4th, 1907, and had not been traced.

The Chairman added that there were several other matters requiring investigation. The London Wire Cordage Co, who rented a part of the premises in Ascham Street, and who, according to the books, had had many transactions with the company, were now returned as creditors for £75 odd, but the Official Receiver, with the assistance of Mr. Norton, had been investigating the claim. It appeared that they were returned as creditors in consequence of certain entries being credited to their account just prior to the liquidation. If those entries proved to have been improperly credited, the London Wire Cordage Co. would figure as debtors to, instead of creditors of, the estate. Then there were payments amounting to £959 on bills to Miss Minnie Benjamin which would have to be scrutinised. That lady was sister to Mr. Lewis Benjamin, and Mr. Ernest E. Benjamin had stated that he did not know the circumstances under which those payments were made.

Mr. E. E. Benjamin explained that he was aware that the bills were given to his cousin Minnie in return for money (£1,000) lent to the company.

The Chairman invited Mr. Norton to report to the meeting the effect of the realisation up to that date.

Mr. Norton announced that he had so far received £1,105 on account of the good book debts, and he saw no reason why he should not collect the whole of the amount set out in the statement of affairs. So far as the stock, plant, and lease were concerned, he was asking the Court to authorise their sale by public tender in two lots. First, the lease, goodwill and the plant, which was very well suited for the carrying on of an extensive business, and in the second lot he proposed to offer the stock. If they could not sell in that way as a going concern, the items would be offered separately, but he hoped to sell as a whole, in which case there would doubtless be a substantial surplus of about £1,000 to meet the unsecured debts, after paying off the debentures, preferential claims and expenses. The stock ought to fetch £500, the plant £1,000, the book debts £2,400, and the lease and goodwill, £300, making a total realisation of about £4,200. If, on the other hand, they could not sell as a going concern, they would have to face the realisation of the plant at a great sacrifice, and the prospects of the unsecured creditors would be correspondingly damaged.

The Chairman announced that 37 proofs, amounting to £1,949, had been received, and several proxies were attached in favour of the liquidation being left in the hands of the Official Receiver.

Upon the motion of Mr. Montagu, a resolution to that effect was unanimously carried, and the following committee of inspection was elected to assist in the administration of the estate, viz., Mr. F. G. Quilton, representing the Britannia Rubber and Kamptulicon Co.; Mr. Joseph Parkinson (C. H. Johnson & Sons, Ltd.), and Mr. Chas. Hawkins (Hawkins Bros. & Co., Ltd.).

Appended is a list of the principal unsecured creditors, viz.:—

E. Abrahams & Co., London	£31 2 9
S. Buckley & Sons, Oldham	12 7 0
Henry Bath & Son, Liverpool	47 8 8
John Beard & Co., Manchester	53 8 8
Busk Mills Co., Ltd., Oldham	84 2 3
Bradbury, Son & Co., London	11 9 0
Balth, Stube & Son, Nuremburg	104 2 2
Britannia Rubber, &c., Co., London	256 4 7
Bean & Co., London	15 8 7
Minnie Benjamin, Brighton	215 0 0
George Christie, Ltd., Glasgow	53 4 2
D. Campbell & Co., London	10 4 2
Cie. Française de Métaux, London	131 2 0
Electrical Co., Ltd., London	162 4 2
Fielding & Platt, Gloucester	68 13 0
Felten & Guilleaume, Carlswerk	95 5 2
Gas Light and Coke Co., London	29 11 7
Rudolf Gross, Vienna	34 6 8
Holland & Webb, Ltd., Nottingham	12 7 6
Hawkins Bros. & Co., London	83 14 1
Johnson & Sons, Ltd., Smedley	204 6 0
Rich. Johnson & Nephew, Manchester	42 4 6
Kynochs, Ltd., Birmingham	79 6 0
Land & Sea Kabelwerke, London	151 0 11
Leyland and Birmingham Rubber Co., Leyland	140 12 9
L. Lepersonne & Co., London	84 5 0
London Wire Cordage Co., London	75 7 7
Markische Drahtwerke, Obenahmede	64 10 11
Moss Wire Mills Co., London	39 8 3
Metcalf & Co., London	89 16 10
N. P. Nathan & Sons, Manchester	23 4 6
Pearsall & Co., London	26 19 5
Wm. Riddell & Co., Glasgow	55 8 8
Rheydt Kabelwerke, Rheydt	177 17 4
H. Rallit & Co., London	133 12 7
Soie de Chardonnet, London	65 18 8
M. Seick, London	35 1 7
Thomson & Co., Dundee	18 13 7
Union Cable Co., Ltd., London	19 17 3
Vorwerk & Sohn, Barmen	22 11 0
Jno. Wilkinson & Co., Birmingham	60 2 6

ALBERT DICKINSON, electrical engineer, 19, Upper Mill Hill, and the Electrical Works, Dixon Lane Road, Wortley, Leeds.—An application was made to his Hon. Judge Bompas, K.C., on Monday last, at the County Court House, Leeds, for this debtor's discharge from bankruptcy. It was reported that the receiving order was made on the debtor's own petition in 1906, the proofs admitted amounting to £3,637, and the assets, so far as they were not assigned to secured, or partly secured, creditors, were estimated to produce £1,518, but they had only realised £695. The balance available for distribution for costs and for distribution among unsecured creditors was £595, instead of £1,389, as estimated by the debtor. The debtor commenced business in 1896 as an electrical engineer and contractor with £34 capital. He had no machinery. He had to send work out. The debtor's losses in 1½ years amounted to £1,188. He ascribed his failure to insufficient capital, bad management during his absence travelling, and bad debts. The Official Receiver submitted that the debtor had continued to trade after knowledge of his position. Mr. Scriven, who appeared for the debtor, said that there was nothing to show that on December 31st, 1905, the man was insolvent, but there was some evidence to the contrary. Eventually the discharge was granted, subject to two years' suspension.

GEORGE KAYE SPIVEY, late electrical engineer, Wakefield and Batley Carr.—The first meeting of the creditors in this matter was held last week at the Official Receiver's office, 6, Bond Terrace, Wakefield, Mr. J. Bickersteth Ottley presiding. No creditors were present or represented, therefore no resolutions were passed, and the estate remains in the hands of the Official Receiver.

Condensing Plant Contracts. — THE MIRRLEES WATSON CO., LTD., Glasgow, have recently received orders for a number of condensing plants, amongst which are the following:—

For John H. Wilson & Co., Birkenhead.—Surface condensing plant.
For the National Electric Construction Co., for Rhondda trams.—Surface condensing plant.
For Huddersfield Corporation.—Elevated counter-current jet plant dealing with 120,000 lb. steam per hour 28½ in. vacuum with cooling tower water.
For Trafford Park Electric Supply.—Second repeat.
For John Brown & Co., Ltd., Sheffield.—Elevated jet condensing plant.
For the British Thomson-Houston Co., for City Road power station.—Third repeat; and for Rangoon.—Second repeat order.

Italy.—A company has just been formed in Milan with a capital of £12,000 and the title of La Società Italiana per le Lampade Elettriche Z., to manufacture electric lamps.

The New Central Criminal Court.—The Commissioners of this Court have been considering the ineffective ventilation and heating of the buildings.

Meter Approved.—Notice appeared in the *London Gazette* on Tuesday last of the Board of Trade's approval of Wright's electricity meter (Hatfield's solution) deposited with it by the REASON MANUFACTURING CO., LTD.

Trade Statistics of Denmark in 1906.—The following statement of the imports of electrical and other goods into Denmark during 1906 is taken from the recently issued trade statistics; the figures for 1905 have been added for purposes of comparison, and information is given as to increases and decreases:—

	1905. Kroner.	1906. Kroner.	Increase or decrease. Kroner.
Electric Cables and Wire—			
From Sweden	9,400	801	− 8,599
„ Germany	285,572	626,448	+ 340,876
„ Great Britain ...	57,381	18,815	− 38,566
„ Holland	20,761	79,247	+ 58,486
„ Other countries ...	6,886	289	− 6,597
Total	380,000	725,600	+ 345,600
Accumulators—			
From Germany	168,537	189,486	+ 20,949
„ Holland	511	593	+ 82
„ France	280	400	+ 120
„ Other countries ...	40,031	21	− 40,010
Total	209,359	190,500	− 18,859
Galvanic Elements—			
From Sweden	2,425	61	− 2,364
„ Germany	3,297	1,383	− 1,914
„ France	31	—	− 31
„ Other countries ...	—	5,822	+ 5,822
Total	5,753	7,266	+ 1,513
Carbons for Arc Lights—			
From Sweden	304	61	− 243
„ Russia	4,200	—	− 4,200
„ Germany	35,498	27,398	− 8,100
„ Great Britain ...	119	5,475	+ 5,556
„ Belgium	5,230	20,721	+ 15,491
„ France	2,808	3,701	+ 893
„ United States ...	3,400	—	− 3,400
„ Other countries ...	—	844	+ 844
Total	51,559	58,200	+ 6,641
Incandescent Lamps—			
From Sweden	771	1,239	+ 468
„ Germany	49,318	59,900	+ 10,582
„ Great Britain ...	238	533	+ 295
„ Austria	93	37	− 56
„ Other countries ...	880	1,821	+ 941
Total	51,300	63,530	+ 12,230
Telegraph and Telephone Apparatus, and Electrical Apparatus not elsewhere mentioned—			
From Norway	297	22,273	+ 21,976
„ Sweden	5,006	18,686	+ 13,680
„ Germany	583,039	993,835	+ 410,796
„ Great Britain ...	2,220	11,487	+ 9,267
„ Holland	400	2,193	+ 1,793
„ Belgium	11,916	120	− 11,796
„ France	12,809	13,163	+ 354
„ United States ...	45,483	8,200	− 37,333
„ Other countries ...	4,380	229,043	+ 224,663
Total	665,500	1,299,000	+ 633,500
Machinery of Iron or Steel—			
From Norway	96,815	166,345	+ 69,530
„ Sweden	910 708	731,244	− 179,464
„ Germany	7,412,052	8,647,998	+1,235,946
„ Great Britain ...	1,259,396	1,674,122	+ 414,726
„ Holland	195,855	235,406	+ 39,551
„ Belgium	118,100	111,184	− 6,916
„ France	62,390	140,863	+ 78,473
„ United States ...	2,453,877	3,413,896	+ 960,019
„ Other countries ...	584,140	581,180	− 2,960
Total	13,093,333	15,702,238	+2,608,905
Other Machinery of Various Kinds—			
From Sweden	7,566	12,763	+ 5,197
„ Germany	126,535	126,192	− 343
„ Great Britain ...	31,565	68,470	+ 36,905
„ United States ...	8,624	4,000	− 4,624
„ Other countries ...	33,876	72,375	+ 38,499
Total	208,166	283,800	+ 75,634

N.B.—Krone = 1/1⅛.

For Sale.—The Executive Council of the Irish International Exhibition is inviting tenders for the sale of the central station switchboard, also a quantity of underground cable. Some particulars appear among our advertisements in this issue.

The Renard Train.—We have received from the RENARD ROAD AND RAIL TRANSPORT CORPORATION, LTD., of 82, Victoria Street, S.W., a copy of regulations recently passed by the Antwerp municipal authorities authorising the use of the Renard train in the city and docks there. We understand that in the summer of last year Messrs. de Roubaix Oedenkoven & Co., chemical manufacturers in Antwerp, took over to that port at their own expense a complete Renard train, and conducted exhaustive trials of the train chiefly in conveying goods from the docks through the city to their factories. These trials were very carefully watched by the municipal engineers there, and they were so satisfactory that Messrs. de Roubaix Oedenkoven at once decided to abandon their existing form of traction in favour of the Renard system, and have placed orders with the Renard Co. for the trains. It is for the purpose of permitting the train to run that these regulations were passed by the authorities.

Catalogues and Lists.—BRITISH ARC LAMPS, LTD., 9½, Union Court, Old Broad Street, E.C.—Four-page circular containing some particulars, illustrations, and a note of prices, of their new long-burning arc lamp which is now ready to be placed on the market.

THE BASTIAN METER CO., LTD., Bartholomew Works, Kentish Town.—Small 8 pp. pocket booklet describing the Bastian electrolytic meter as it is now manufactured by them. We understand that owing to the large increase in the sale of the meter all business is now being done direct from the works and not through agents as hitherto.

MESSRS. MAVOR & COULSON, LTD., Glasgow.—The January date card issued by this firm gives a diagram illustrating the rapid progress made in the sale of their Pick-Quick coal-cutters between 1897 and 1907. Of the business done during 1907—81 per cent. consisted of repeat orders. It is claimed that the machines supplied during the above 11 years represent a saving of "more than £360,000 per annum."

MESSRS. E. S. HINDLEY & SONS, 11, Queen Victoria Street, E.C.—New catalogue just issued, 64 pp., in which are published a large number of new illustrations (generally excellent half-tone blocks) of their steam engines, suction gas plants, gas engines, hoisting engines, tubular, Cornish, Lancashire, and other boilers, auxiliary steam appliances, also circular saw benches, band saw machines, &c. Descriptive information, dimensional, price, and other details are given in more complete form than in the last edition of the catalogue.

MESSRS. SIEMENS BROS. & CO., LTD., Queen Anne's Chambers, Broadway, Westminster, S.W.—Catalogue (16 pages) got up in the usual admirable style of the firm, with binder case, and well illustrated, in which appear particulars of their electrical resistance pyrometers, testing sets, and accessories. Among the interesting material in the list, is a description of a direct-reading instrument by means of which the temperature of the pyrometer is read off direct in degrees Fahr. or Cent.

MESSRS. ALFRED HERBERT, LTD., Coventry.—Section "C" of their catalogue, new edition, containing views and full description of their No. 1 Universal cutter-grinding machine, with illustrated directions for its use.

MESSRS. WARD & GOLDSTONE, Springfield Lane, Salford.—Four-page leaflet containing brief particulars and lists of sizes and prices of their "Sampson" auto-transformers which are stated to be meeting with a large sale, because they enable metal filament lamps to be connected direct. It is claimed that on private house lighting particularly these transformers will be found of great value, as they make possible the use of 25-volt Osram lamps, which give about the same light as the ordinary 16-c.p. lamps, and are about equal in size and appearance, and can be burnt in any position.

MESSRS. MICHAEL PAL & CO., Parliament Mansions, Victoria Street, S.W.—24-page catalogue of engineering specialities. The lines illustrated include oil-saving and waste-cleaning plants, small steam turbines, turbine tube cleaner, electro-magnetic lamps, rotary pumps, drain valve, electric motors and dynamos, &c. A separate circular is devoted to the low-pressure turbine plants with exhaust steam accumulators and condensing plant made by Messrs. Louis Schwarz & Co. A.G., of Dortmund, for whom Messrs. Pal are sole agents in the United Kingdom and Colonies.

THE INDESTRUCTIBLE CABLE CO., 47-51, Park Street, Southwark, S.E.—Small pamphlet containing some "brief remarks" concerning their indestructible wires and cables, and the process of their manufacture and laying, and the advantages of "Indestructible" insulation. A card of specimens of the wires has also been received.

MESSRS. LAING, WHARTON & CUNNINGTON, of 7, Great Newport Street, London, W.C.—"General Supplies" pocket list for 1908. It contains some 200 pages of enamelled paper, on which are well shown, with brief description and prices, and here and there tabulated matter, a variety of electrical manufactures, including such things as advertising novelties and signs, batteries, bells and bell pushes, insulators, ceiling roses, distribution boards, switches and switchboard accessories, fans, cooking and heating apparatus, engines and dynamos, motors, arc and incandescent lamps, streak-o'-light stage novelties, portable electric saws and benches, rudder-motors, telephones, wires and cables, and many other things that want of space prevents our enumerating.

THE BRITISH INSULATED AND HELSBY CABLES, LTD., Prescot.—Copy of the first edition of the "B.I. Handbook," a well-bound volume of 368 pages with gilt edges. It is divided into two sections, the first particularising the principal manufactures of the company, and the other setting forth a great deal of general and technical information that is calculated to be of interest to electrical and other engineers. The contents of Section I are well known to most of the trade; they include various representative

lines—such as paper-insulated and lead-covered cables for lighting and power, telegraph and telephone cables, joint and junction boxes, overhead and other tramway material, insulators and sundry materials and tools for telegraph and telephone line construction, also telephone switchboard and telegraph apparatus. Section II contains a great deal of matter and tabulated data and diagrams on very many subjects of technical electrical interest, including tabulated particulars of copper conductors, wire gauges, conversion tables, fusing effects of electric currents, and many other matters, but it also covers such things as the New Patents Act (Digest), the I.E.E. wiring rules, and a list of the insurance companies that have adopted them, Board of Trade Regulations, Special Rules for electricity in mining and so on. Indexes to both sections appear at the end.

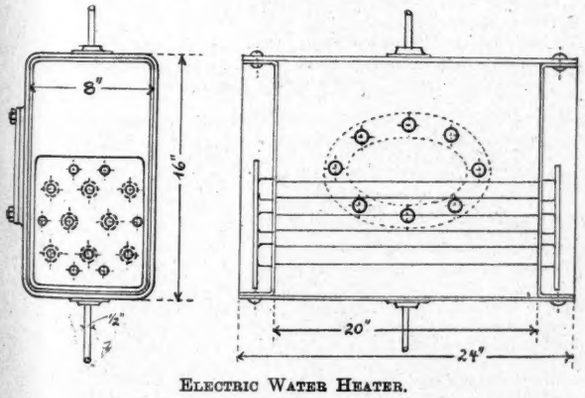
MESSRS. A. REYROLLE & CO., LTD., Hebburn-on-Tyne.—Two new pamphlets:—No. 2 describing and showing their L.T. ventilated tubular fuses with removable handles; No. 44 relating to their ironclad double and triple-pole switches.

MR. ARTHUR KOPPEL, 26, Clement's Lane, Lombard Street, London, E.C.—56 pp. catalogue (No. 754) giving illustrations and particulars of their various electric overhead line material, including trolley wire hangers, mechanical ears, crossings, frogs, section and strain insulators, bracket-arm suspension telephone guards, and so forth. Towards the end pictures of their trolley collectors appear, and a number of loose leaflets show their various types of electric locomotives.

THE CREDENDA CONDUITS CO., Birmingham.—An illustrated catalogue and price list of conduits and fittings for electrical installations, manufactured by this company. In the course of nearly 80 pages, light and heavy gauge, screwed and unscrewed conduits and fittings, bends, cross-pieces, elbows, junction-boxes, switch and ceiling-rose fittings, bracket arms, and a variety of accessories for conduit work, are shown and prices and sizes are set out in tabular form. A number of pages are devoted to a tabulated summary of prices. A stock of the Credenda conduit manufactures is held in London by Messrs. Baxter & Caunter, of 86, Charing Cross Road, W.C., who are the firm's London agents.

From the ARMORDUCT MANUFACTURING CO., LTD., we have received a refill block for the perpetual desk calendar issued by them several years ago.

Hot Water for Baths.—Replying to a query in our "Correspondence" column last week, MESSRS. ISENTHAL & CO., of 85, Mortimer Street, W., send us particulars of their electric water heaters for baths. The one shown in the figure is for domestic use, and has a capacity of 7½ gallons. It is intended to be put on circuit during the night, and the consumption of the eight



ELECTRIC WATER HEATER.

immersion tubes in it amounts to between 1 and 2 KW., resulting in a temperature of 80-90° Centigrade for the water. This quantity of hot water will be sufficient when mixed with cold water from the tap for a bath. A larger type with a capacity of 50 gallons is exactly similar in construction. It is made of wrought iron and provided with 15 "Elektra" immersion tube heaters, having a consumption of 10 KW. and capable of heating water in two hours to 80-90° Centigrade. This larger cistern is used both for heating water for the bath and also for preparing hot water for use in the kitchen, by which means the various cooking operations on the electric heaters can be dealt with in a comparatively short time.

THE PHŒNIX ELECTRIC HEATING CO., LTD., of 17, Morwell Street, W.C., also write stating that this is one of their specialities, and inviting readers to visit their works and see the apparatus at work.

Book Notices.—We note that our esteemed contemporary, *l'Eclairage Electrique*, has reverted to its original title—*La Lumière Electrique*, while our French namesake, *La Revue Electrique*, has changed its appearance, increased its size, and incorporated with itself the *Bulletin* of the Union des Syndicats de l'Electricité, of which it is now the official organ.

The Practical Electrician's Pocket-Book and Diary, 1908. Edited by H. T. Crewe. London: S. Rentell & Co. Price 1s. and 1s. 6d.—This neat little book is now in its *n*th edition—we don't know the value of *n*, as it is not stated, but it must be approaching double figures. It has been thoroughly revised and brought up to date, some old matter having been cut out and new sections added. Amongst the latter are Ignition Accumulators, Photometry, the Home Office Rules, &c., the book being increased in size by 32 pages. The leather-bound copies contain coupons for insurance against death by electric shock, and the usual forms for requisitions and estimates are included after the diary. There is a great deal of useful information in the pocket-book.

"Electric Arc Lamps." By J. Zeidler and J. Lustgarten. London: Harper & Bros. 1908. 5s. net.

"Science Examinations, 1907." Reports and lists of successful candidates in competitions. London: Wyman & Sons. Price 6d.

"Report of the Board of Education for the Year 1906-1907." London: Wyman & Sons. Price 6d.

"Standardisation Rules of the American Institute of Electrical Engineers." Second edition. New York: The Institute. Price 10c.

"Electric Power Transmission." By Louis Bell. London: A. Constable & Co., Ltd. 1908. Price 16s. net.

"Annual Report of the Chief of the Bureau of Steam Engineering, U.S. Navy." 1907. Washington: Government Printing Office.

"Modern Electrical Theory." By N. R. Campbell. Cambridge: The University Press. 1907. Price 7s. 6d. net.

"Who's Who, 1908." London: A. and C. Black. 1908. Price 10s. net.

"Writers' and Artists' Year-Book, 1908." London: A. and C. Black. 1908. Price 1s. net.

"Who's Who Year-Book, 1908." London: A. and C. Black. 1908. Price 1s. net.

Mining Drills.—A Reuter despatch from Johannesburg says that the Government is co-operating in the contest for a prize of £1,000, offered by Mr. Reyersbach on behalf of the Chamber of Mines, for the best drill produced by January 1st, 1909. The Government proposes to offer an extra prize of money and to allow drills for the competition to be imported free of Customs duty and railway freight.

Liquidations.—D. SANTONI & CO. (1906), LTD.—A petition presented by a creditor, Carl Quitmann, lamp merchant, 3, Cloth Street, London, for winding up this company, is to be heard in the Courts on January 28th.

VICTOR ARC LAMP CO., LTD.—Creditors must send particulars of debts, &c, to W. C. Penny, liquidator, 8, Arthur Street West, London, by February 22nd.

PSYCHILOID, LTD.—A meeting is to be held at 18, Norfolk Row, Sheffield, on February 21st, to hear an account of the winding up from the liquidator, G. S. Greening.

ELECTRICAL TURNERY, LTD.—A meeting is to be held on February 24th, at 76, Cheapside, E.C., to hear an account of the winding-up from the liquidator (Mr. T. M. Gordon).

The Installation at Ray Mills, Stalybridge.—With reference to the "Contract Closed" notice which appeared in our last issue (p. 105) in which it was stated that MESSRS. BRUCE PEEBLES & CO., LTD., had received the order for the complete electrical equipment of the above mills, MESSRS. MORRISON AND ROEBUCK, of Blackpool, write pointing out that this is not quite correct, as they "have received the order for the whole of the electric lighting and for all the cables, also for the switchboard, and are at present on with the work."

Cowans' Switchgear Contracts.—MESSRS. COWANS, LTD., of Manchester, have recently received orders for the following:—

For the Admiralty.—Switchboards for H.M. battleships *Minotaur* and *Shannon*, also for Gibraltar Dockyard.

Seven switchboards for the lighting of the Franco-British Exhibition, including Andrews' patent discriminating devices.

A repeat order for sub-station switchgear for the Hammersmith Borough Council, including Andrews' reverse-current relays.

Callender's Benevolent Fund.—We have before us a copy of the fifth annual report and accounts of Callender's Hospital and Distress Fund (Belvedere). The year was a heavier one for claims for medical and other assistance, while owing to trade conditions in the district and a consequent reduction of members, the receipts were lower than in 1906. The income from weekly penny subscriptions was £180 against £204 in the preceding year. The total out-payments to hospitals, convalescent home, &c., were £185 as against £208 in 1906, and 81 grants aggregating £90 were made to members in distress, who appealed for financial assistance. Donations from the company (£50) and directors and friends privately, produced £70. The general meeting of the fund was held at Erith on January 18th, with Mr. T. O. Callender in the chair. Should any firm in the electrical or allied industries desire any information concerning the fund and its work, they can obtain it on application to the hon. sec. and treasurer (Mr. W. E. Wimhurst) at the works at Belvedere, Kent.

Medal for Ozoniser.—We learn that the Royal Sanitary Institute has awarded a medal to Ozonair, Ltd., for their ozone generating apparatus.

Buxton Health Congress.—We are asked to call our readers' attention to the forthcoming exhibition in connection with the Buxton Congress of the Royal Institute of Public Health, which is to be held from July 18th to 24th next. It is believed that this exhibition will afford certain classes of firms an excellent opportunity to show their latest appliances, inventions, patents, &c.

Trade Announcements.—THE PREMIER ACCUMULATOR CO, of Northampton, announce that in order to extend and to cope with the greatly increased demand for their products, they have converted the business into a Limited Company with a nominal capital of £25,000, which will be carried on under the control of Mr. Stephens as before.

MESSRS. J. & H. GREVENER, of Eldon Street House, E.C., suppliers of electric lighting accessories and cables, inform us that they can now also supply the "Resilta" insulating paints and varnishes for electrical purposes.

Mr. H. A. Balchin, F.C.I.S., and Mr. G. F. Schulz, who were respectively secretary and chief inspecting engineer to the Alliance Electrical Co. for seven years, have recently joined in partnership under the title of BALCHIN, SCHULZ & Co., to carry on the business of electrical and general engineers and contractors. The address of the firm is Lennox House, Norfolk Street, Strand, W.C.

MESSRS. SPENCER & Co., of Hanway Place, Hanway Street, W., carry out japanning work of all kinds, including that for reflectors and shades for electric fittings, &c., also repair work in connection with tin and iron goods.

BRITISH ARC LAMPS, LTD., have removed from Leysian Buildings, 118, City Road, E.C., to 9½, Union Court, Old Broad Street, E.C.

MESSRS. DRYSDALE & Co., LTD., pump makers, announce that henceforth all business communications should be addressed to them at Bon-Accord Works, Ferry Road, Yoker, Glasgow.

MR. H. GREENSTREET has commenced business as an electrician at 119, High Street, Mile Town, Sheerness.

MR. CHAS. PULLAN has opened more commodious offices and show-rooms at Market Place, Shipley, to which address fittings manufacturers are invited to send catalogues, &c.

MESSRS. TETLEY & Co., of Salford, have appointed MR. H. C. HODGSON, electrical and mechanical engineer, of 577, Mansion House Chambers, 20, Bucklersbury, London, E.C., as their sole selling agent for London and district. We understand that Mr. Hodgson has had a large experience in electrical manufactures and supplies, and can quote for all types of special switchboards and switchgear.

The E.M.F. MANUFACTURING Co. have commenced business at 10, Ironmonger Lane, Cheapside, E.C., for the manufacture and supply of all electrical requirements for light, power, heat, &c. The company will make a speciality of switches and switchboards to specification, and will also supply all kinds of metal filament lamps, cables, carbons, carbon brushes, &c. In addition they claim to hold the master patents of certain sign switches, fuse and distributing systems for lighting and power.

MESSRS. FALK, STADELMANN & Co., LTD., announce that they have withdrawn all advances in respect of their electrical fittings catalogues, Nos. 191 and 232, as from the 1st inst.

MR. T. W. SAMPSON, A.M.I.E.E., has commenced business as an electrical engineer at George Yard, Barnsley.

MESSRS. RHODES MOTORS, LTD., of Doncaster, have appointed MR. FRANK PARKINSON as their representative for the Yorkshire district. Mr. Parkinson's temporary address is Elden Mount, Guisley, near Leeds.

Catalogues for South Africa.—The *Daily Telegraph* publishes the following statement on the above subject "from a correspondent":—"Under the Customs Union Convention at present applying to all our South African Colonies, there is a duty payable on catalogues and price lists entering the country of 25 per cent. *ad valorem*, or 2d. per lb., whichever may be higher. Considerable objection has been raised to this item as tending to restrict trade and prevent British manufacturers from making their wares known in South Africa. The several parties to the union have, therefore, decided to relax the restrictions, and they have now decided that ordinary catalogues and price lists sent by post which weigh less than 8 oz. are free of duty, but in the case of South African firms sending large quantities through the post, the duty still holds good. To avoid the inconvenience of assessing the Customs duty at the other end, the Cape of Good Hope, Transvaal and Natal Governments have established a system whereby prepayment can be made, by senders in Great Britain, of the Customs duty leviable. This they can do by obtaining stamps to the amount of the duty from the various Agents-General in London. The Transvaal has already inaugurated the system; the Agent-General for Natal is on the point of doing so, and the Cape Colony will not be long in following their lead. It is hoped, however, that, when the Customs Convention Conference meets next March, the duty will be done away with, as it certainly seems inequitable that efforts to extend British trade should be handicapped in this way, especially as our fellow countrymen in South Africa suffer from the fierce competition of Germany."

Germany.—The Deutsche Elektromobil Gesellschaft "Fram" is the name of a company which has just been formed in Dusseldorf with a capital of £5,000 to acquire and develop the electrical vehicle patents of Sr. E. Cantono, of Rome.

Crompton's Works Staff Dinner.—The annual dinner of the works staff of MESSRS. CROMPTON & Co., LTD., electrical engineers, Chelmsford, took place in the club room on Saturday, the 18th inst. The company numbered about one hundred, and Mr. A. J. Hodgson, the works manager, presided. Mr. W. G. Bickmore, in proposing the toast of "The Firm of Messrs. Crompton & Co, Ltd.," said the success of the company was so closely associated with their own interests that, in drinking this toast, they were drinking to their own prosperity. The chairman, in replying, said that the general manager and directors had yearly contributed handsomely towards the benevolent and other objects in connection with the works. Mr. W. J. F. Freeland proposed "The Health of the Chairman" in a humorous speech, and this was received with musical honours. In response, the chairman said that when he took office, just over two years ago, he felt that he should have the support of the whole of the staff, and he was glad to say his feeling had been proved out and out.

LIGHTING and POWER NOTES.

Acton.—An electrical exhibition promoted by the U.D.C. has been held during this week at the Public Baths, Salisbury Street. The exhibition, which was to be opened by Mr. Herbert Nield, M.P., includes a good selection of lighting, power and heating appliances, displayed by local firms, and including well-known specialities of the B.T.-H. Co.; General Electric Co.; Dowsing Radiant Heat Co.; Siemens Bros.; Mawdsleys, Ltd.; Falk, Stadelmann & Co.; Laing, Wharton & Cunnington, &c. Musical entertainments, cinematograph and electro-medical exhibitions, &c., held every evening, and an exhaustive catalogue indicate the efforts of the Acton electricity department, under Mr. Martin Blair, to promote the success and popularity of the exhibition.

Aylesbury.—The B. of T. has informed the U.D.C. that the E.L. order has been revoked.

Barnes.—The U.D.C. has decided on the advice of its engineer to replace all defective Nernst street lamps with tantalum lamps. A detailed report is being prepared on the subject by the engineer.

Bexley.—Negotiations are proceeding between the U.D.C. and the Foots Cray Electricity Supply Co. for a supply of electricity for the Lamorbey district.

Canada.—Following the lead of Toronto, all the important industrial towns of Western Ontario have voted in favour of the proposal to take electrical power in bulk from Niagara Falls, under the scheme of the Government Hydraulic Commission. Large majorities are reported from Hamilton, London, St. Thomas, Brantford and Stratford.

Carlisle.—A loan of £5,000 for E.L. purposes has been applied for by the T.C.

Chislehurst.—In order to increase the efficiency of the supply of electricity to Chislehurst, the E.L. Co. is about to erect a transmission station at Lower Camden, at a cost of £3,000.

Continental Notes.—GERMANY.—An electric station is to be equipped for the purpose of lighting the Swinemünde railway stations, workshops, &c., by electricity.

Croydon.—The Corporation has decided to install coal-conveying plant in the generating station, at an estimated cost of £2,525, made up as follows:—Coal bunkers, £980; conveyor, £850; automatic measurer, £195; building, £500. It is estimated that there will be a direct saving of £350 per annum.

Dundee.—All the requirements in connection with the Electric Lighting Extension Order, recently lodged by the T.C. with the B. of T., have been complied with, intimation to this effect having been received. The purpose of the Order is to extend the area of supply so as to include the whole of the district annexed under the recent prov. order.

Falkirk.—The Carronbridge Wire Rope Works, opened by Dunn & King, Ltd., will be driven entirely by electric power, an agreement having been come to with the Scottish Central Power Co. to supply energy.

Harrogate.—The T.C., having received applications for energy for lighting from persons outside the borough, it has been decided to apply to the B. of T. for a licence to supply in such cases under the Electric Lighting (Clauses) Act, 1899.

Haslingden.—It was reported at the Council meeting on January 16th, that the B. of T. was prepared to extend the Electric Lighting Order held by the Corporation for a further period of 12 months.

The B. of G. has finally approved plans for the erection of a new infirmary and provision for electrically lighting the existing premises and the new building.

Hull.—On January 14th a burn-out occurred of three armatures of the large 2,200-volt D.C. generators at the Corporation electricity works, resulting in a failure of the supply in the centre of the town for about half an hour. Subsequently, a special meeting of the Committee decided, on the recommendation of the engineer, to purchase three Lahmeyer generators to replace the above. An amendment that the work be thrown open to public tender, was defeated.

Ilford.—The U.D.C. has decided to extend the plant at the electricity station at a cost of £27,000.

For power purposes, where the consumption exceeds 20,000 units per year, energy will be supplied at 1d. per unit.

India.—Both the Perambur workshops of the Madras Railway and the Negapatam shops of the South Indian Railway are being fitted with electric-power installations. Four Diesel oil-engine sets of 1,500 KW. are being used in the former case and steam engines in the latter.

Linthwaite.—Negotiations are in progress with the Huddersfield T.C. for the street lighting of the U.D.C.'s area.

London.—The Uxbridge and District Electric Supply Co., Ltd., and the Metropolitan Electric Supply Co., Ltd., have applied to the Board of Trade for approval to the transfer by the former company to the latter of a portion of the undertaking authorised by the Uxbridge and District Electricity Supply (Extension) Order of 1903.

ISLINGTON.—The B.C. has agreed to apply for a loan of £23,304 for extending the electricity station, as mentioned in our last issue. It has also been decided to transfer £1,076 from the reserve, to meet payments for goodwill in respect of the exchange of electric lighting areas with the County of London Co.

BATTERSEA.—Messrs. Mather & Platt, Ltd., have summoned the Council in respect of a spare armature supplied, payment for which has been deferred owing to alleged non-compliance with the contract.

FINCHLEY.—A statutory public meeting of ratepayers has been held to consider the Bill which the U.D.C. is promoting to obtain further powers in regard to electricity supply. As a result, it was decided to drop the claims relating to supply outside the district and to supply of electrical fittings.

L.C.C. AND LOANS TO BOROUGH COUNCILS.—The question of electric lighting loans was raised at Tuesday's meeting of the L.C.C. An advance of £2,154 to the Bermondsey B.C. for extension of mains in the neighbourhood of Surrey Commercial Docks was approved without comment, but an application made by Stepney B.C. led to some discussion. It appeared from the report of the Finance Committee that Stepney had applied for sanction to borrow £42,150 for the equipment of a new generating station to be erected at Blyth's Wharf, Limehouse. The total estimated cost of the station was £36,565, and the Committee recommended the Council to sanction £22,000 pending the receipt of further details of the scheme. The recommendation of the Committee was passed. It was also decided to advance £3,000 to the Woolwich B.C. for extensions of mains, house services, and meters.

CAMBERWELL.—The B.C. has decided to petition against the London Electric Supply and London and District Electricity Supply Bills with a view to safeguarding the special purchase clauses applying to the area.

SOUTHWARK.—The London Electric Supply Corporation has suggested to the B.C. the advantage of securing a bulk supply from it. The Council's engineer reports that the cost of linking up to the company, including transforming plant, would amount to from £3,000 to £3,500, and that additional capital expenditure would be necessary for the further development of the undertaking; and in the result the E.L. Committee decided to take no action.

Lowestoft.—The T.C. has decided to oppose the Bill of the Great Eastern Railway Co., which seeks power to sell electricity to private consumers.

Mytholmroyd.—The B. of T. has informed the U.D.C. that as no good purposes would be served by allowing the E.L. order to be re-enforced it was proposed to revoke it forthwith.

Portslade.—The Brighton T.C. has informed the U.D.C. that it intends applying by Bill for a prov. order enabling it to supply energy in outside areas, including the three townships of Shoreham, Southwick and Portslade.

Richmond.—The T.C. is to petition against the London and District Electricity Supply Bill and the London Electric Supply Bill.

Sedgefield.—With reference to a proposal to supply the workhouse with electricity from the County Asylum, the L.G.B. has informed the B. of G. that if it is able to submit a scheme for lighting, with electricity obtained from a body that has power to supply it, the Board will be prepared to consider the proposal favourably. The County Asylum Committee does not possess power to sell electricity.

South Lancashire.—A correspondent in this district assures us that a score or more spinning and weaving concerns in Manchester and adjoining areas are about to adopt electricity for driving, &c.

Stretford.—A L.G.B. inquiry was held on Friday into the application of the U.D.C. for a loan of £42,718 for electricity purposes; of this amount £36,995 is for structural alterations and additional plant. There was no opposition.

Victoria.—Recently Mr. C. H. Merz, accompanied by various Government officials, paid a visit to the site of the proposed 25,000-acre power reservoir on the Goulburn River. The dam would be 1,700 ft. long and 180 ft. high, and its construction would impound the river for a distance of 30 miles back, necessitating the removal of some 30 miles of railway which follows the course of the river, also of the township of Yea, which would be submerged to a depth of 35 ft. It is estimated that the removal of the railway would cost £230,000; the whole of the work would involve an expenditure of £1,250,000 to £1,500,000, and take five or six years to complete.

Wath.—The B. of T. has informed the U.D.C. that as it has failed to discharge its obligations under the E.L. order, the Board has decided to revoke the latter immediately.

Walton (Surrey).—The U.D.C. has approved of the application of the Woking Electric Supply Co. for a line of buried high-tension cables through its district been Byfleet and Cobham, agreeing also that the Woking company may sell energy in bulk to the Urban Electric Supply Co. for retailing to Walton consumers.

West Australia.—The Kalgoorlie municipal electric lighting scheme for the financial year just closed, showed a total revenue of £22,603, and a gross profit of £7,285, as against £8,805 for the previous year, the decrease being due to the lower rate charged. There are now 31 miles of streets lighted.

Windsor.—The T.C. has asked the Electrical Installation Co. to submit terms for lighting the town by electricity.

Woolacombe (Devon).—A scheme for providing this seaside township with electric light is being considered. It is proposed to distribute overhead at 100 volts pressure, and to use tantalum lamps largely.

TRAMWAY and RAILWAY NOTES.

Belfast.—The Corporation's Bill for the purpose of purchasing the Whitewell and Cavehill Tramway at £60,000, came before the Examiners of the Standing Order Proofs at the House of Commons, on the 20th inst. After the usual formal evidence, the Examiner declared that the Standing Orders had been complied with, and the Bill will in due course come before the House. It is in connection with this Bill that a plebiscite of the ratepapers of the city is about to be taken, there being a good deal of local opposition to the acquirement of the tramway at the figure mentioned. However, it is pretty certain that the result will be in favour of the purchase of the tramway.

Continental Notes.—ITALY.—The Committee elected for the construction of railways across the Dolomite Alps, have finished the preliminary work, and applications for authorising these lines have already been made to the Government. A company is being formed for the construction and working of the new system. The lines to be constructed are three: the first, from Bribano to Agordo; the second, connecting the Cadore line with Cortina di Ampezzo, with a branch line to Auronzo; the third, from Feltre to Primolano. The three lines will have a total length of more than 100 km., and will be of narrow gauge. It is proposed to install hydraulic works to provide the power for electric traction.

The Government has assigned a credit of 70 million lire for electric traction on various lines having steep gradients and long tunnels. A concession has been granted to a company composed of French, Belgian and Italian capitalists for the exploitation of an electric railway between Rome and Naples.

It is also announced that Il Consiglio d'amministrazione delle Ferrovie has authorised the sum of 1,137,000 lire (about £45,480) to be expended on the conversion to electric traction of the branch railway line from Savona to S. Guiseppe, and also for the installation of a steam power station for the production of the electric energy.

FRANCE.—A fog which hung over the outskirts of Paris on Sunday last was responsible for a serious collision between electric cars at Vitry-sur-Seine. Fifty persons were injured, chiefly from cuts caused by broken glass.

NORWAY.—An underground electric tramway is to be constructed in Christiania at a cost of £75,000.

HOLLAND.—With two exceptions all the tramway routes in Rotterdam have now been electrified.

AUSTRIA.—According to the *Eisenbahnblatt*, the investigation made by the Austrian Southern Railway in regard to the proposed introduction of electrical working, has so far proceeded that the problem appears solved from a technical point of view, and the directors will occupy themselves with the question shortly. It is intended first of all to take in hand the Brenner railway, especially the southern section, and the work would be carried out in such a way that a special capital appropriation on the part of the company would not be required. The advanced stage of the preliminary work suggests that the scheme will assume concrete form in the near future. On the other hand, the Vienna *Zeit* states that the project has not emerged from the initial stage, and that the introduction of electric traction on the railway will be difficult, owing to the question of finance. In addition to this, the military authorities stipulate that after conversion it shall still be possible for the railway to be traversed by steam locomotives, although this should offer no difficulties whatever.

Huddersfield.—The T.C. has agreed to a recommendation of the Committee that, on several sections double lines should be constructed at an estimated cost of £12,573, which is to be charged to depreciation.

The borough treasurer's financial report for the nine months ended December 31st, 1907, shows that the capital outlay to date is £412,902. The miles run are 1,473,459, against 1,369,022 last year. The income is as follows: Passengers, £62,656; postmen, £225; parcels, £878; advertising, £606; coal haulage, £630; and sundries,

£11—making a total of £65,006, or 10·59d. per car-mile, compared with £61,890 and 10·85d. last year. The total working expenditure is £32,054, or 5·22d. per c.m., as against £31,344., or 5·49d., last year. The gross surplus is £32,952; but rent of leased lines absorbs £904; interest on capital, £10,050; redemption of debt, £7,402; and depreciation at 3 per cent., £9,290, leaving a net surplus of £5,306, or ·87d. per c.m., compared with £2,900 and ·51d. last year.

Heston and Isleworth.—The U.D.C. has decided not to oppose the London United Tramways Co.'s Bill, which, so far as relates to the Council's district, proposes to extend the time for acquiring property for road widening, by two years.

India.—A Diesel engine of 500 B.H.P. is being installed at Howrah as a prime mover for the tramways power plant now under construction for the Calcutta Tramways Co., Ltd.

London.—Traffic on the Baker Street and Waterloo Tube was almost suspended on Friday last, owing to the breaking of an axle at the Westminster Bridge Road Station.

L.C.C.—At Tuesday's meeting of the L.C.C. the Highways Committee presented a report on the subject of the proposed purchase of the Harrow Road and Paddington tramways. It appeared that several letters had been exchanged with the B. of T., which finally sanctioned the scheme on December 18th, and notice was served on the company on December 21st, 1907. The Committee stated that the arrangements for the purchase of the undertaking would probably involve considerable negotiations, and possibly a reference to arbitration, and it recommended the Council to enter into negotiations and to take all necessary steps in the matter.

Mexbro'.—A Sheffield paper, commenting on the Mexbro' and Swinton (Dolter) Tramway, draws attention to the flashing caused by imperfect action of the skate and studs, and states that several minor accidents have already been caused by this. It appears that experiments are *still* being made with a view to remedying this.

Morecambe.—A town's meeting has been held to protest against the proposed municipalisation of the local tramways, a large majority voting against the project.

New South Wales.—The tramway revenue for the December quarter of 1907 amounted to £260,427, and the expenditure to £210,059. These amounts compare with £232,517 and £196,099 respectively in 1906.

Richmond.—The T.C. has agreed on terms to support the application of the London United Tramways Co. for a line across Kew Bridge, which points to the approaching conversion of the present L.U.T. horse line between Kew and Richmond, and the running of through cars to Richmond. The T.C., however, will oppose the application of the West London, Barnes and Richmond Tramways Bill promoted on behalf of the Richmond Electric Light and Power Co., for a line of tramway in Sheen Road. The chief objection is to overhead wires, but otherwise the T.C. is ready to negotiate.

South Africa.—The Durban Corporation Tramways carried some 11,493,288 passengers during 1907, earning 16·67d. per car-mile. The total receipts amounted to £85,392, working expenses to £51,031, and the net profit to £2,236. The system covers some 16 miles of route, and 1,219,806 car-miles were run. The results are mostly poorer than in the preceding year, due to the increased cost of energy and to the continued depression in the district.

South Lancashire.—It is stated that the Lancashire United Tramways Co. has finally decided not to proceed with the construction of tramways from Farnworth to Little Hulton, and from Walkden to Middle Hulton *via* Little Hulton.

Southport.—The Tramways Committee is at present considering the advisability of extending the tramway system along Nevill Street, Coronation Walk, the Promenade and Park Road.

Victoria.—The Prahran-Malvern Electric Tramway Bill has been passed by the Legislature; the line will cost £76,260 to construct and will involve some £13,000 additional expense in railway reconstruction. The system will be controlled by a trust nominated by the two Councils.

TELEGRAPH and TELEPHONE NOTES.

Australia.—The cost of erecting the telephone line between Melbourne and Sydney was £46,686, and the average weekly revenue from the line has been £67.

By a fire in Melbourne early in December, the Commonwealth Postal Department sustained a loss of about £20,000 worth of telephone material. In order to replenish the stock, the Postmaster-General authorised short-dated tenders and the despatch of cables to Europe, ordering new stocks of requisites for despatch by the first outgoing mail steamers. A proposal to put the telephone services of the Commonwealth under the control of one permanent head, with a view to securing greater efficiency throughout, is being considered by the Government.—*Australian Mining Standard.*

German East Africa.—A telegraph station for international messages has just been opened at Aruscha, 50 miles from Moschi, German East Africa.

St. Lucia.—The report for 1906-7 states that the telephone system consists of 112½ miles of trunk and 54¾ miles of branch lines, or a total of 167¼ miles. During the year £218 was spent on reconstruction and improvements. There were 110 subscribers to this service. Receipts amounted to £565, and expenditure to £1,072, thus showing a deficit of £507. The expenditure, however, includes £500 paid for the purchase of the military telephone system and stores, which were taken over by the Government on the removal of the troops.

South Africa.—The annual report of the Durban municipal telephones for the year ended July 31st, 1907 (Mr. W. Manson, manager), states that the gross revenue was £12,153, and the expenditure £12,387, there being a loss of £235 on the year's working. The total capital expenditure has been £93,262, leaving a balance of £6,738 of the £100,000 borrowed for the department. The total number of subscribers is 1,018, the total calls for the year being 3,390,400, or an average number of calls per subscriber of 10·41 per day.

Telegraph Insurance.—The Copenhagen correspondent of the *Daily Telegraph* states that a new form of insurance against loss caused by delayed telegrams or errors in the text of messages will be started in February. The idea was planned by a Danish telegraph official, and carried out by a limited company, the Danish Lloyd, which has an agreement with the State Telegraph Department, which is taking a great interest in the matter. The company covers risks due to delays or mistakes in telegrams taking place during transmission. The premiums are paid by means of stamps to be affixed to the telegrams when despatched. They are issued by the company, and sold at all telegraph offices. A yearly subscription can be arranged, and the premium is then reduced. Insurances may be effected not only for Denmark but for all other countries with which arrangements have been made.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Curacao-Coro Curacao-La Guayra Curacao-Maracaibo } Closed..	.. Jan. 12, 1906 ..	..
Lagos-Kotonou	.. Dec. 4, 1907 ..	January 18
Tarifa-Tangier	.. Jan. 18, 1904 ..	..
Port Arthur-Chifu (Closed)	.. Mar. 9, 1904 ..	..
Brest-Dakar	.. July 22, 1907 ..	January 17
Scotland-Orkney and Shetland Islands ..	.. Jan. 2, 1908 ..	..
Bathurst-Bissao	.. Dec. 25, 1907 ..	..
Trinidad-Demerara	.. Jan. 8, 1908 ..	January 16
Paramaribo-Cayenne	.. Jan. 11, 1908 ..	..
Cayenne-Salinas	.. Jan. 14, 1908 ..	..
Teneriffe-St. Louis du Senegal	.. Jan. 16, 1908 ..	..
Landlines.		
Puerto-Barrios	.. Aug. 2, 1902 ..	..

Wire Thefts.—Last week 15 cwt. of wire was stolen from the National Telephone Co.'s poles near Croydon. Since then over two tons of wire have been stolen in Hooley Woods, near Merstham.

Wireless Telegraphy.—The German Imperial Post Office authorities, as was recently mentioned in this journal, entertained the opinion that the Imperial prerogative or State monopoly of telegraphy also applied to wireless telegraphy. But it now turns out that another institution has held this view of the question to be incorrect, the contrary idea having actually been maintained by the highest Court (Reichsgericht) in the country. It appears that the Reichsgericht was asked last summer to act as arbitrator between the Imperial Post Office authorities and one of the Federal States in a matter in which the former demanded that the State concerned—the particular kingdom is not specifically mentioned—should sequestrate certain wireless telegraph equipment. The Court, however, decided that the Telegraph Act of April 6th, 1892, was not applicable to the wireless method. As a consequence of this decision the Imperial Post Office authorities have for some time past been engaged on the preparation of a scheme for the amendment of the law on the subject, and an amending Bill has just been introduced into the Imperial Parliament. The Bill stipulates that electrical telegraphic installations, which transmit news without metallic connecting wires, and in the case of German ships for ocean or inland navigation, telegraphic installations which are not exclusively for use within the vessels, can only be established and worked with the consent of the empire. The Bill also proposes to authorise the Imperial Chancellor to make regulations regarding the working of telegraphic installations on foreign ships for ocean and inland navigation when these vessels are in German waters. It is to be hoped that in the event of the Bill becoming law, which is highly probable, the British Government will take into consideration the question of applying to German vessels when in British waters regulations of a similar character to those which that country intends to make operative in regard to British ships in Teutonic waters.

A shareholder in the Marconi Wireless Telegraph Co., writing to the *Financial Times* of the 17th inst., complains that the directors have not issued a report since September 30th, 1905, and comments on the fall in price of the shares from £7 to 8s. 9d.

Orkney and Shetland have not been in telegraphic communication with the mainland since December 27th, and it has been announced that until the cable is repaired wireless telegraphy will be installed.

It is announced that the Marconi service between London and Montreal will be opened for private telegrams early next month.

CONTRACTORS' COLUMN.

OPENINGS FOR NEW BUSINESS.

AINSDALE.—Two houses for A. Brown & Co. in Clive Road.
Three houses for Rimmer & Lewis in Sandringham Road.

ALNWICK.—New Primitive Methodist Manse at Seahouses. G. Reavell, jun. architect, Narrowgate, Alnwick.

ARBROATH.—Steam laundry in Forfar Road. Carver & Symon, architects Arbroath.

ASHTON-UNDER-LYNE.—Salvation Army Halls in Old Street and Williamson Street.
Shop and garage in Old Street and Cavendish Street for Wood and Co., Ltd., wine and spirit merchants.

BARNSLEY.—Houses in Queen's Avenue. E. W. Dyson, architect, 10, Regent Street, Barnsley.

BATLEY.—Improvements and alterations at Hick Lane Mills, for G. and J. Stubley, Ltd.

BLACKPOOL.—House and shop in Victoria Road, Cleveleys, for Mr. Howarth.

BOLTON.—Colliery developments. S. Scowcroft & Sons, Rosehill Collieries.
New workshops. Dobson & Barlow, textile machinists.

BOURNEMOUTH.—Houses and shops in Southbourne Grove for Mr. Pellew.
Houses at Winton for J. Francis and J. Belbin.

BRADFORD.—Proposed Labour Home for the Church Army.
Additions to New Girls' Secondary School at Belle Vue for the T.C. City architect, Whittaker Buildings, Brewery Street, Bradford.
Alterations to shops, Nos. 63, 65, 67 and 69, Manchester Road, for the Corporation. City architect, Whittaker Buildings, Brewery Street, Bradford.

BRIDGEND.—Additions to Abergarw Brewery Bottling Stores, Brynmenin. J. T. Jenkins, architect, Porth, Rhondda.

BRIDGNORTH.—New grammar school (£5,773). T. J. Mason, builder, Stourbridge.

BRISTOL.—New Congregational Church at Hanham (£5,000). La Trobe and Weston, architects, 20, Clare Street, Bristol.

BURSLEM.—Important extensions to Wedgwood Institute. F. Bettany, borough surveyor, Burslem.

CANNOCK.—New higher standard school at Chadsmoor for the U.D.C. Baile and McConnal, architects, Bridge Street, Walsall.

CARLISLE.—Electric power installation at Holme Head Works for Ferguso Bros., woollen manufacturers.

CHELMSFORD.—Proposed extension to the Infirmary.

CHINGFORD.—Elementary school (£5,642). Surveyor to Essex County Council, Chelmsford.

CLEATOR MOOR.—New club premises. Pickering & Crompton, architects, 11, Lowther Street, Whitehaven.

COVENTRY.—Drill Hall for T. I. Stevens.
Additions to the Standard Motor Works, Foleshill Road, for C. Friswell.
Eight houses in Kingsway for H. Clarke & Sons.

CROYDON.—88 houses in Leavden Road. A. Carter Clout, Heather Lodge, Thornton Road, Croydon, builder.
Nine houses in Wiltshire Road. A. Gosheron, "Westgate," Holmesdale Road, Croydon, builder.
Coal and ash conveyor and coal bunkers at the electricity works for the T.C. Borough Electrical Engineer, Croydon.

CLIFTON (near MANCHESTER).—Railway sidings at Astley Green, for Clifton and Kersley Coal Co.

DARLINGTON.—Place of worship in North Lodge Terrace. F. Jennings, builder.
Residence in Millbank Road. R. Blackett & Son, builders, 8, Paradise Terrace, Darlington.

DEWSBURY.—New nurses' home (£4,000).
Detached residence in Reservoir Street. J. Firth & Sons, architects, Vulcan Road, Dewsbury.

DOVER.—Extensive additions to South Front Barracks for the War Office. W. H. Grigg, builder, 14, Worthington Street, Dover.
Club premises in Curzon Street. J. Wise, builder.
Houses in Park Avenue (£1,600). C. Horton, builder.

DUNDEE.—Restoration of warehouse in Constable Street for Malcolm Ogilvie and Co., manufacturers.
Warehouses for Halket & Adam, Union Place.

DURHAM.—New Council School at Ryhope. J. Eltringham, architect, 62, John Street, Sunderland.
New Council School at Cornforth Lane. T. W. T. Richardson, architect, 57, High Street, Stockton-on-Tees.

FALKIRK.—New school in High Bonnybridge (proposed). James Anderson, chairman of School Board.

FERRYHILL.—Houses for T. Golightly, E. Robinson and G. W. Lazenby.

FLEETWOOD.—Additions to old Fleetwood Arms Hotel, including shops, for L. Cowen.
Factory near Wyre Dock for I. Spencer & Co.

FRINTON-ON-SEA.—Additions to the Esplanade Hotel, for Miss K. Prior.
Shops and houses in Connaught Avenue, for J. W. Bare.

GLASGOW.—Extension of Buchanan Street Station, for the Caledonian Railway Co.

HALIFAX.—Additions to works. J. F. Walsh and G. Nicholas, architects, Museum Chambers, Halifax.
Semi-detached houses in Linden Road. Jackson & Fox, architects, 7, Rawson Street, Halifax.

HARROGATE.—Houses (10) in Cavendish Street, Bilton, for John Owston.
Church at Harlow Terrace for the Vicar of St. Mary's.

HEBBURN.—High-tension mains to be laid from Hebburn to Jarrow substation. County of Durham Electrical Supply Co.

HULL.—Electrification of new bridge at Sculcoates, for the T.C. (£2,500).
Tramcar shed for the T.C. A. E. White, city engineer, Town Hall, Hull.
Thirteen houses at Preston, for A. Bond.

INCE (near WIGAN).—Spinning mill to be built, for a new company.

KENDAL.—Residences in Sedbergh, for E. Jones and Miss Taylor. John Hutton, architect, Kendal.

KNARESBOROUGH.—Detached residence in Boroughbridge Road, for F. Ingham.

LEIGH (SOUTH LANCS.).—New weaving shed, for newly-formed syndicate.

LEIGH-ON-SEA.—Proposed new town hall (£1,000).

LLANDRINDOD.—Extensions to the Rock House Hotel,

LLANGOLLEN.—New Schools at Llantysilio (£1,285). D. Davies & Son, builders, Llangollen.

LONDON (KINGSLAND, N.E.).—Additions to No. 26, Enfield Road. H. Lovegrove, High Street, Shoreditch, E., surveyor.
(UPPER CLAPTON, N.E.).—Ten houses. G. H. Paine, 62, Moorgate Street, E.C., architect.
(BERMONDSEY, S.E.).—Houses and Shop in Upper Grange Road and Lynton Road. T. Slowman, Cowan Street, S.E., builder.
(BERMONDSEY, S.E.).—Factory in The Grange. G. Parker, 124, Sumner Road, S.E., builder.
(BERMONDSEY, S.E.).—Installation of electrical energy in factory of E. & T. Pink, Staple Street, S.E., jam, &c., manufacturers.
(BERMONDSEY, S.E.).—Installation of electrical energy in factory of Champion & Slee, Tower Bridge Road, S.E., vinegar brewers.
(BERMONDSEY, S.E.).—Re-erection of premises in Bermondsey Street. E. Crosse & Co., 11, Bermondsey Square, S.E., architects.
(MARYLEBONE, W.).—Additions to 120, Edgware Road. Hudson and Hunt, 2, York Place, W., architects.
(HAMMERSMITH, W.).—Additions to Carlton Academy of Dancing, Uxbridge Road, for W. F. Hurndall, 84, Blackfriars Road, S.E.
(ISLINGTON, N.).—Additions to St. Mary Magdalene Schools. H. D. Searles-Wood, 157, Wool Exchange, E.C., architect.
(WANDSWORTH, S.W.).—Buildings in Eatonville Road. W. C. Poole, 62, Belleville Road, Wandsworth Common, S.W., architect.
(NORTH KENSINGTON).—Residence, St. Helen's Gardens. Trant, Brown & Humphries, 332, High Road, Kilburn, N.W., architects.
(WANDSWORTH, S.W.).—Shops in Mitcham Lane. A. Wellings, Leigham Court Road, Streatham, surveyor.
(ISLINGTON, N.).—Installation for power purposes, by Nobbs & Sons, 94, Blackstock Road, N., dyers and cleaners.
(ISLINGTON, N.).—Installation for power purposes, by Green & Sons, Ltd., Mildmay Avenue, N., saw mill proprietors.
(LEWISHAM, S.E.).—18 houses. Tompkins & Connew, 6, Stondon Park, Brockley, surveyors.
(CHELSEA, S.W.).—Factory and offices, Beaufort Street. H. J. Cope, 7, John Street, Adelphi, W.C., surveyor.
(LEWISHAM, S.E.).—18 houses in Inchmery Road, seven houses in Ardgowan Road, and six houses in Culverley Crescent, Inchmery Road. Norfolk & Prior, Catford, architects.
(W.).—Alterations to 328-30, Oxford Street, prior to opening by the Hanon Gingell Shoe Co., Ltd.
(ENFIELD WASH).—Grocery warehouse. Frank Bethell, 28, Queen Anne's Place, Bush Hill Park, N., architect.
(TOTTENHAM, N.).—31 houses. G. W. Rowley, 278, Philip Lane, Tottenham, N., builder.
(TOTTENHAM, N.).—Nine houses in Fairview Road. E. Evans, 253, Lavender Hill, S.W., agent.
(TOTTENHAM, N.).—Bottling store, &c., for Watney, Coombe, Reid and Co., Ltd., Portland Place, Tottenham, N., brewers.
(TOTTENHAM, N.).—Re-erection of shop in High Road. Rev. A. Champion, 7, Kingswood Avenue, Kilburn, N.W.
(W.).—Rebuilding premises in Wells Street, and altering premises in Oxford Street, for Hyam & Co., Ltd., clothiers, 134-140, Oxford Street.

MALDON (ESSEX).—Mineral water factory for W. S. Markham. P. M. Beaumont, architect, Maldon.

MANCHESTER (TRAFFORD PARK).—Shed extension for Anglo-American Oil Co.
Extensive premises in Brown Street. Briggs, Wolstenholme and Thornely, architects, 51, North John Street, Liverpool.
(FLIXTON).—Semi-detached houses in Princess Road, for Turner and Walkden.
(STRETFORD).—Special subjects centre. E. Woodhouse, architect, 88, Mosley Street, Manchester.

MORTLAKE.—Seven houses in Glendower Road. Chas. Ellis & Co., Portman Estate, East Sheen, Richmond, builders.
Extension of electrical plant in brewery of Watney, Coombe, Reid and Co.

MANSFIELD.—Houses in Crown Street, for W. Chadbourn.

NORTHAMPTON.—Isolation hospital at Berrywood Asylum for Northants C.C. (£2,000).

NORWICH.—Electric motor and other apparatus for the T.C. A. E. Collins, city engineer, Guildhall, Norwich.

OLDHAM.—New theatre for the Oldham Varieties Co., Ltd. Thos. Taylor, architect, Queen Street, Oldham.
Colliery developments contemplated by Platt Bros., textile machinists, Oldham.

PERTH.—Extension to Stormontfield School. Mr. McIntosh, clerk of works, Scone.
Block of offices, &c., for the General Accident, Fire and Life Assurance Corporation.

PETERBOROUGH.—Business premises in Broad Bridge Street for Mr. Fitzwilliam.

PONTYPRIDD.—Twenty-two villas. A. L. Thomas, architect, Church Street Chambers, Pontypridd.

POOLE.—House in Balston Road for J. Newbury. T. Heath, architect.
Residence and stables for Mrs. Watkins. S. Tugwell, architect, Richmond Chambers, Bournemouth.

RICHMOND-ON-THAMES.—Municipal dwellings. J. H. Brierley, borough surveyor, Town Hall, Richmond, Surrey.

ROYSTON.—Showrooms and workshops in Kneesworth Street for Mr. Sanders.

RUABON.—New schools at Pontfadog (£1,460). J. & C. Davies, builders, Glyn, Ruabon.
New schools at Penycae for Denbighshire C.C. (£3,420). J. Jenkins, builders, Johnstown, Ruabon.

ST. ANNE'S (LANCS.).—Villa residences for G. H. Willoughby, T. Whiteside, J. Holding, Thos. Eaves, and Miss Bailey.

ST. HELENS.—Extensions, including new Ward and Operating Theatre at the Providence Hospital.

SEAFORD (SUSSEX).—Baptist Chapel. Smee & Houchin, Byron House, Fleet Street, E.C., architects.

SLIGO.—Improvements to the Harbour (£20,000).

SOUTH SHIELDS.—Rebuilding Tiger Inn P.H., King Street, for A. Deucher, Ltd. J. H. Marten, architect, 50, King Street, South Shields.
New banking premises, offices, shops, &c., King Street and Fowler Street, for North-Eastern Banking Co. Ltd. J. H. Marton, architect, 50, King Street, South Shields.
Parish Hall, Sunday School, &c., St. Michael's Church, Westoe. Hy. Grieves, architect, Albany Chambers, King Street, South Shields.

STOCKPORT.—New ring spinning mill (60,000 spindles). Stott & Sons, architects, Manchester; T. and W. Meadows, contractors, Stockport.

STRABANE (Co. TYRONE).—New Technical Schools. L. Bradley, director of the Strabane Technical Committee, Mount Royal, Dungannon.

SUTTON (SURREY).—Block of shops in High Street, for Sir H. G. Smallman.
Semi-detached residences on Highfields Estate, for P. V. Windebank.

SWADLINCOTE.—Shops in High Street for J. H. Haywood.

SWANAGE.—Banking premises for Lloyd's Bank. Parsons & Hayter, architects.
Residence in Manor Road for F. C. Atkey. Lawson & Reynolds, architects, Yelverton Chambers, Bournemouth.

SWINTON (MANCHESTER).—Workshop. R. L. Harrison, Ringlow House, Moorside.
TEDDINGTON.—House and shop, corner of Cedar Road and High Street, for Mr. Tomalin.
TODMORDEN.—New Hippodrome in Halifax Road.
USK (MONMOUTHSHIRE).—New school for the Monmouthshire Education Committee (150 children).
WALKDEN (MANCHESTER).—Seven houses Walkden Road and Hodge Road, for James Cocker, builder, Walkden.
WALSALL.—Electric light plant house at Green Lane, for the Birchills Furnaces, Ltd.
WARWICK.—Workshops for Sheasby & Hobbis.
WHISTON (STAFFS.).—New school at Ravenfield. J. W. Totty, architect.
WHITSTABLE.—Houses in Tankerton Road for W. Camburn, and in Northwood Road for F. S. Gann.
WIDNES.—Villa residences in Park Avenue for E. Guy.
WIMBLEDON.—E.L. installation at Durnsford Road temporary school for T.C.
WIGAN.—Colliers' Arms Hotel to be rebuilt for Albion Brewery Co., Ltd.
King's Head Hotel and Millstone Inn to be rebuilt for Magee, Marshall & Co., Wigan.
Developments at various local collieries. Wigan Coal and Iron Co.
WREXHAM (NEW BROUGHTON).—New public schools for Denbighshire C.C. W. D. Wiles, architect, 42A, High Street, Wrexham.
New schools at Tan-y-vror (£1,200). J. Jones, builder, Bettws, Bridgend.
New schools at Minera for Denbighshire C.C. (£1,380). S. Moss, builder, Coedpoeth, Wrexham.
YORK.—Important additions to the General Post Office.

CONTRACTS OPEN and CLOSED.

OPEN.

Australia.—ADELAIDE.—March 11th. The Postmaster-General requires tenders for the supply of one common-battery switchboard, 400 subscribers' telephones and 400 protectors.

MELBOURNE.—May 26th. The Postmaster-General invites tenders for a common-battery switchboard, together with all associated frames, racks, power plant and parts and apparatus for consumers. See this column for January 3rd.

SYDNEY.—March 4th. The Representative of the Commonwealth in London (Captain R. Muirhead Collins, C.M.G.) has received tender forms, specifications, &c., in connection with the supply of 33 switchboards for private branch exchanges for common-battery working, for which tenders will be received by the Deputy Postmaster-General, Sydney. Specifications, tender forms, &c., may be obtained at the Commonwealth Offices in London, 72, Victoria Street, S.W., where also preliminary deposits on tenders may be paid.—*Board of Trade Journal.*

Austria.—Tenders are about to be invited by the municipal authorities of Villach for the establishment of a central electric lighting station in the town.

Bermondsey.—February 17th. Stores, &c., for the Council's electricity and destructor works. See "Official Notices" to-day.

Brazil.—March 5th. Tenders will be received by the Public Works Department at Rio de Janeiro from persons able to undertake the electric lighting and power supply for the Capital of Santa Catharina State. The Brazilian Government will guarantee 6 per cent. interest on the capital involved.

Bristol.—February 17th. Electric lighting installations for various buildings, &c., at Royal Edward Dock, now constructing; also supply and maintenance of cables and appliances for conveying electrical energy to the various boards at the Old and New Docks, at Avonmouth, for the Docks Committee. For full particulars see "Official Notices" January 17th.

Cheltenham.—January 31st. The Corporation invites tenders for the annual supply of electric light fittings. Particulars may be obtained from the Borough Surveyor, Municipal Buildings.

Edinburgh.—February 10th. Extension switchboard panel for M'Donald Road electricity works. See "Official Notices" to-day.

Edinburgh.—January 29th. Tenders are invited for electric lighting installations at the Scottish National Exhibition at Edinburgh. See "Official Notices" to-day.

France.—PARIS.—February 18th. Tenders are required by the municipal sewage department for pumps worked by three-phase motors, estimated to cost £7,000. A deposit of £160 is required. Particulars may be obtained from the Municipal Council, Hotel de Ville.

PARIS.—January 31st. The Post and Telegraph department requires tenders for four lots of lead-covered telephone cables of 27 conductors each. Full details may be obtained from the Sous-Secretaire de l'Etat, 103, Rue de Grenelle.

Germany.—February 6th. The Prussian Railways, telegraph branch, require tenders for 336,500 porcelain insulators; 77,000 metres telegraph cable; 25,000 kg. wire rope; 493,300 kg. zinced iron wire; 8,800 kg. insulated wire; 3,600 kg. copper wire, &c. Particulars may be obtained, for 1s. 6d. cash, from the Hansverwaltung, Dornhof No. 28, Cologne.

Great Yarmouth.—February 1st. One 400-KW. D.C. traction steam dynamo for the Electricity Department. See "Official Notices" January 10th.

Holland.—February 1st. The Twent Electric Tramways Co. invite tenders for laying rails and crossings and accessory works on their Enschade-Gernerburg works. Particulars may be obtained from the Secretaire de la Société du Tramway Electrique de Twent, at Enschade.

Hornsey.—February 17th. Electric wiring, &c., of certain buildings for the Council. See "Official Notices" to-day.

Islington.—February 18th. Electrical and engineers' stores for the B.C. See "Official Notices" to-day.

Leeds.—February 10th. Steam and exhaust piping, &c., for the Corporation E.L. department. See "Official Notices" to-day.

London.—L.C.C.—February 4th. Five miles of low-tension lead-covered cable, and two miles of telephone cables, &c.; also laying of ducts, &c., and reconstruction for electric traction of the tramways in Caledonian and Seven Sisters Roads for the L.C.C. See "Official Notices" January 17th.

N.E. Railway.—January 27th. The directors of the North-Eastern Railway are inviting tenders for the erection of an electrical sub-station at West Hartlepool.

Portsmouth.—February 3rd. Coal for the Tramways Committee. See "Official Notices" to-day.

Portugal.—March 11th. The Nova de Gaya municipalities require tenders for the construction, maintenance and working of electric tramways.

Rangoon.—March 31st. The Revenue Secretary of the Burma Government will receive tenders for the concession for 30 years, renewable for a further period of 20 years, for rubber plantations at Mergui (Tenasserim).

Rathmines and Rathgar.—February 13th. Coal and other supplies for the U.D.C. electricity works. See "Official Notices" to-day.

Rawtenstall.—February 7th. Balancing set, transformers and transforming plant, boilers, feed pumps, condensers, piping, &c., for the Corporation electricity supply department. See "Official Notices" to-day.

Rome.—January 28th. The Italian Government Post and Telegraph department requires tenders for 20,000 accumulator jars and 17,600 insulator holders.

Russia.—SAMARA.—The T.C. is, according to an advertisement in the *Times*, inviting tenders from contractors for the construction and working of a central electric station, and also for taking charge of the organisation of the tramways at Samara. Particulars and conditions of the concession from l'Administration de la Ville de Samara.

Sheffield.—February 10th. Stores for the Tramways Committee. See "Official Notices" to-day.

Tunbridge Wells.—February 1st. High and low-tension cables for the Electricity Department. See "Official Notices" January 17th.

Turkey.—The municipal authorities of Smyrna are about to invite tenders for the establishment of a central electric lighting station in the town.

Villach.—Tenders will shortly be asked for electrical equipment, &c., for the municipality. An expenditure of about £120,000 has been agreed to.

Wimbledon.—February 18th. Flame arc lamp carbons for one year for the electricity department. See "Official Notices" January 17th.

Wimbledon.—February 18th. One 1,000-KW. turbo-alternator, with condensing plant; two water-tube boilers, economisers, pipe-work and feed pump; switchboard and switchboard gallery, for the Corporation electricity department. See "Official Notices" January 10th.

CLOSED.

Belfast.—The Belfast Harbour Commissioners received nine tenders for the construction of the new harbour tramway. The engineer and electrical engineer of the Trust recommended that of Messrs Dick, Kerr & Co., Ltd., subject to certain modifications. The line will connect the famous Queen's Island with the city. The tender is subject to the approval of the Corporation.

Croydon.—The T.C. has accepted the tender of the British Electric Transformer Co. for the supply of two 100-KW. transformers, at £211.

Llandudno.—The U.D.C. has accepted the tender of the Tudor Accumulator Co., Ltd., for additional electrical plant, at £1,741.

London.—The Metropolitan Asylums Board received the following tenders for the installation of electricity for light and power at the Mead Ambulance Station:—

T. Potter & Sons, Ltd.	(accepted)	£139 0
Speedy, Eynon & Co.		143 0
C. Pullan		145 0
A. V. Gifkins & Co.		149 0
Smeeton & Page		178 0
Electrical Co., Ltd.		180 0
Dargue, Griffiths & Co., Ltd.		183 0
H. J. Cash & Co., Ltd.		185 0
Edmundson's Electricity Corporation, Ltd. ..		186 10
G. Weston & Sons		189 0
A. Plucknell		192 0
J. Wilson		192 0
C. Cooper & Co.		210 0
Jenkins & Cawte		229 15
Fulham Electric Supply Co.		253 0
W. G. Cannon & Sons, Ltd.		267 0
Kevan Electric Co., Ltd.		335 0

The Engineer-in-chief's estimate was £130.

The Board has also accepted the tender of T. W. Potter & Sons, at £49 10s., for the installation of certain electric lighting at the South-Western Ambulance Station.

ISLINGTON.—The B.C. has extended the tender, at £548, of Messrs. Daniel Adamson & Co, for repairs to an engine at the generating station, to include repairs to steam pipes and foundations, estimated to cost £152.

L.C.C.—The Highways Committee of the L.C.C. has accepted the tender of Messrs. Appleby's, Ltd., amounting to £513 10s, for a car traverser at the central car repair depôt. Nine selected firms were invited to tender, but only the former and Messrs. Heenan and Froude, Ltd, who quoted £580, sent in offers for the contract.

The tender of Messrs. Bullers, Ltd., has been accepted by the L.C.C. for the supply of 2,000 track insulators, at 3s. 5½d. each, and that of Callender's Cable and Construction Co., amounting to £800, for the delivery of 2 miles of jumper cable.

Lowestoft.—The T.C. has accepted the tender of the Electrical Co., Ltd., for the supply of meters for a year, and that of Messrs. Siemens Bros., Ltd., for a 45-H.P. locomotive, at £472.

Southampton.—The T.C. has accepted the tender of Messrs. Willans & Robinson, Ltd., for the supply of a steam dynamo, at £7,851.

Southport.—The tender of the United Electrical Car Co., Ltd., for two top-covers for double-deck cars, at £115, has been accepted by the Corporation Tramways Committee.

FORTHCOMING EVENTS.

To-day's Events (Friday, January 24th).—At 7.30 p.m. At the Lit. and Phil., Newcastle-on-Tyne. North-East Coast Institution of Engineers and Shipbuilders. Paper on "Torsion Meters as Applied to the Measurement of the Horse-Power of Marine Steam Turbines," by Mr. J. H. Gibson.

At 5.45 p.m. Northampton Institute Engineering Society. Mr. J. C. Rennie on "Electrical Illumination."

Saturday, January 25th.—At 3 p.m. Royal Institution. Prof. Gisbert Kapp on "The Electrification of Railways." (Lecture II.)

At 7 p.m. Newcastle-on-Tyne. North-East Coast Institution of Engineers and Shipbuilders. Among the subjects to be introduced and discussed are:—"Electricity compared with Gas for both Lighting and Power"; "Apprentices' Advancement Scheme" (Mr. Spence's paper); "Premium and Bonus System."

Monday, January 27th.—At 8 p.m. Sheffield Society of Engineers and Metallurgists. Paper on "Electrical Driving of Rolling Mills," by Mr. G. J. Hooghwinkel.

Tuesday, January 28th.—At 8 p.m. At the Common Hall, Hackin's Hey, Dale Street, Liverpool. Liverpool and District Electrical Association. Discussion on Mr. R. Geenhalgh's paper, "Fuel Economy in Steam Generating Plants."

Wednesday, January 29th.—At 8 p.m. Society of Arts. "The New Patents Act," by Mr. J. W. Gordon.

Friday, January 31st.—At 9 p.m. Royal Institution of Great Britain. Prof. E. Rutherford, F.R.S., on "Recent Researches on Radio-Activity."

At the Hotel Cecil. Electrical Engineers' Ball.

ELECTRICAL ENGINEERS, R.E. (VOLS.).
(LONDON DIVISION.)

The following orders are issued:—

Monday, January 27th.—"A" Company. Technical drill, 6.30 p.m.
Tuesday, January 28th.—"B" Company. Infantry drill (recruits), 6 p.m.
Wednesday, January 29th.—"A" Badge exam. for "A" and "B" Companies, at 6 p.m.
Thursday, January 30th.—"C" Company. Infantry drill (recruits), 6 p.m. technical drill, 7 p.m.
Friday, January 31st.—"D" Company. Infantry drill (recruits), 6 p.m. technical drill, 7 p.m.
Saturday, February 1st.—Week-end run at Coalhouse for "D" Company.

(Signed) J. H. S. PHILLIPS, Capt.,
Acting Adjutant.

NOTES.

Greenwich Boiler Explosion.—Since our leading columns went to press, the Board of Trade Commissioners have delivered their judgment. The primary cause of the explosion is declared to be the supply of a badly constructed boiler drum by the makers, the immediate cause being the neglect of the electric light company to reduce steam when the crack was discovered in the end of the drum.

The Commissioners, says the *Morning Post*, found that the plate supplied by Messrs. Beardmore, of Glasgow, was of good normal quality, and the fracture in the end plate was in no way due to bad material. Messrs. Babcock & Wilcox supplied a drum with a defectively-constructed end plate, which was injured by rough handling due to bad workmanship; therefore they were primarily responsible for the explosion. There was no suggestion of responsibility against the South Metropolitan Electric Lighting Co. With regard to Mr. Bowden, their chief engineer, he was no doubt a highly-qualified electrical engineer, but as engineer in chief he was responsible not only for the electrical part of the works, but for the boilers. He ought to have known there was danger in working the drum after the leak was discovered, and should have ordered it to be shut down. They were sorry to have to hold him responsible. The Commissioners thought that where a chief engineer was an electrical specialist it was desirable that there should be some arrangement of the staff so that his responsibility for the safe working of the boilers should be lessened or transferred. Mr. Constable, the resident engineer, acted to the best of his ability, but he must have realised that the drum was in a serious condition, and they therefore held him also responsible.

The Commissioners ordered that those responsible should pay in respect of the Board of Trade costs and expenses of the inquiry the following sums:—Messrs. Babcock & Wilcox, £400; Mr. McLaren (their manager), £50; Mr. Bowden, £50; and Mr. Constable, £30. In conclusion, the Commissioners stated that nothing had occurred to throw any doubt upon the safety of thermal storage drums.

Shutting-down Boilers.—Some discussion has taken place recently as to the time required to get a boiler shut down, by which may be understood a reduction of its steam gauge pressure to nil. Ordinarily it is desirable to allow the process to occupy as long a time as possible, in order that the minimum of stresses may be set up in the structure of the boiler, that the scale in the boiler may be kept as soft and non-adhesive as possible, and that the brickwork about the boiler may cool as soon as the boiler. In such a case, it is not even necessary to draw the fires or to blow off steam at the safety valves or stop valves, unless some good use can be made of such steam. Nor need the dampers be kept open. The boiler may simply be left to cool down by radiation loss. But usually more haste will be necessary, and in such a case the fires may be drawn and a small draught allowed to pass round the flues, such draught being allowed to be greater when the other boilers are not demanding draught. A full draught may thus sometimes, as at night, be allowed to pass to the chimney by way of the by-pass flue, if there is an economiser. Then, to hurry the cooling of the boiler, cold feed water may be pumped in and the boiler blown out simultaneously, but the water level must not be lowered until the brickwork is cold.

In cases of emergency, the most rapid cooling may be secured if the feed pumps are of great capacity, and other boilers are temporarily left unfed. Usually all that practice demands is a sudden cessation of further steam making and a reduction of pressure. This is the time, say, when the danger is too great to allow considerations of ordinary operations to have any weight. In such a case the furnace doors may be thrown wide open, and the dampers opened, and the fires smothered with the smallest coal available, or with sand or ashes, preferably wet, in either case. A fire under process of drawing is apt to be much hotter than a smothered fire, and the smothered fire can be drawn before it has time to burn up afresh. Then, meantime, the cold feed must be turned on and hot water blown away so as to keep down the water level to the lowest safe level. Ample cold feed is of more advantage than blowing off.

The letting away of steam must depend on the opinion of the man in charge as to the safety of this. When the emergency is a case of low water in a Lancashire boiler, the object must be to get water into the boiler as quickly as possible, and to get the hot

furnace cold and stiff so as to avoid collapse. Here the furnace doors must be opened wide, and the fireman may endeavour to smother the fires, but he will try to do so without standing directly in front of them, for if the furnace crowns are already hot, they may collapse any minute, and though with first-class mild steel such a furnace may come down without tearing, there always is the risk of this occurring. The act of collapsing will usually bring the crown below the level of the water once more, and the water will set the plate hard and stiff again. The occurrence of low water is not common, since low water valves usually afford an ample warning, and should low-water be within measurable distance, because of feed-water failure from any cause, there is generally time to get the fires drawn before damage can occur. The discovery of a serious shell trouble in any boiler is so rare an occurrence, that rapid reduction of pressure can hardly ever be required from this cause. Such a discovery should receive the most careful attention. No attempt to examine it under pressure should be made, and it is most dangerous to tap a boiler with a hammer when under steam pressure. The fault has not arisen suddenly, and pressure may, probably with safety, be best reduced by drawing fires and putting on feed.

Thermal storage vessels have added a fresh danger to boiler houses, for should they become completely full of water, they may be exposed to considerable shock or over-pressure from the action of the pumps, and as a matter of precaution, it would be desirable that one safety valve of a thermal storage vessel should be of the spring-loaded variety in order to avoid the undesirable inertia of weights. The cooling down of a thermal storage vessel will, of course, depend upon the means provided for getting rid of its hot contents and replacing them with cold water. It is hoped that the arrangement of such vessels may be inquired into as a result of the Greenwich explosion, and that if necessary they may be improved.

The Late Lord Kelvin.—A Reuter telegram from Washington states that a gathering in memory of the late Lord Kelvin was held there on Saturday evening, under the auspices of the Philosophical Society. It was attended by a large number of scientists, and Mr. Bryce was one of the speakers.

At a meeting of leading Belfast citizens on Tuesday, the Earl of Shaftesbury presiding, it was resolved to erect a fitting memorial to Lord Kelvin.

The Board of Trade and the Electric Lighting Acts.—The Board recently received a letter from the T.C. of Hastings, urging the desirability of municipal authorities being empowered to wire premises for consumers, and to supply fittings. The T.C stated that they were adverse to incurring the large expense involved in promoting a private Bill with the express object of obtaining the powers referred to, and they asked whether the Board contemplated introducing a measure for extending the Electric Lighting Acts so as to confer, *inter alia*, upon all local authorities who own electricity undertakings the powers in question. The Board have now replied to the effect that they hope to introduce a Bill next session to amend the Electric Lighting Acts, and in the event of their doing so, the matter to which attention has been drawn by the Hastings T.C. will receive consideration.

Institution and Lecture Notes.—Institution of Electrical Engineers (Leeds Local Section).—A smoking concert is to be held on Thursday, February 6th, at 8 p.m., at the Hotel Metropole, Leeds. The musical programme is being arranged by Mr. T. Harding Churton.

Institution of Automobile Engineers.—On Wednesday evening, at Storey's Gate, Dr. H. S. Hele-Shaw read a paper on "Front Driving, with Special Reference to Electric and Hydraulic Transmission."

Civil and Mechanical Engineers' Society.—On Thursday, February 6th, at 8 p.m., a paper will be read on "Some Devices for the Absorption of Shock on Wheeled Vehicles," by Mr. F. G. Woollard.

Faraday House Old Students' Association.—The fourth annual dinner will be held at the Queen's Hotel, Leicester Square, on Friday, February 21st, at 7.30 p.m, with the president, Mr. G. W. Partridge, M.Inst.C.E., M.I.E.E, in the chair. Tickets may be obtained from the honorary secretary, Faraday House, Southampton Row, W.C.

Electric Cooking Demonstrations.—At the *Tribune* Rendezvous this week (January 20th to 25th inclusive), in connection with the exhibition of winter foods and drinks, electric cooking, &c., demonstrations are being given daily with the aid of apparatus lent by the General Electric Co., Ltd.

The Platinum Trade.—According to an account contained in a newspaper published at Perm, great activity is being displayed in working the new deposits of platinum which have recently been discovered alongside the River Omut. The latter stream is a tributary of the Tschusowa (Tchusovaya), and flows near the Sysertsk works. It is stated that about 400 men are employed in washing the mineral, and that they are recovering about ten Russian pounds per week.

The Union Electric Co.'s Annual Dinner.—On Thursday last week this company's annual dinner was celebrated in the Café Royal, Regent Street, some 104 guests, including the company's staff and friends, being present. Prior to the above function a visit was paid to the company's extensive premises in Park Street, Southwark, which it will be recollected were only opened a little over 12 months ago. Such satisfactory progress has been made by the company, whose specialities in the way of arc lamps, motors, switchgear, and electrical appliances generally, are well known, that a considerable extension of the premises has been made during the year, including a switchgear erecting shop with an equipment of tools, and a new lamp-testing department—the old one having been absorbed by other departments. The company is now specialising in H.-T. cellular and remote control apparatus with a view to catering for industrial power work, and has on hand some important orders for this class of work. In order to cope with the extending business, it has also been necessary to rearrange the office accommodation, which in its present form leaves little to be desired. The chair at the dinner, held at the Café Royal, was taken by Mr Justus Eck, who proposed the Royal and other toasts. Subsequently, an excellent smoking concert was held, the artistes including Miss Ruby Wilson, Dr. Byrd Page, Mr. Walter Helmore and others.

Parliamentary.—*Standing Orders.*—On Saturday the Examiners, Messrs. Campion and Jeune, sat to consider proofs of compliance with Standing Orders in respect of Private Bills. The following, amongst other Bills, were ordered to go forward for first reading: Great Eastern Railway (General Powers), London Electric Supply, Bristol Tramways, Rochdale Corporation, London United Tramways, Merthyr Tydfil Corporation, South Wales Electric Power Distribution Co., Manchester Corporation and Blackburn Corporation.

On Monday the following Bills, amongst others, were ordered to proceed: Stockport Corporation, Burnley Corporation, London Motor Roadway Approach, Leicester Corporation, Belfast Corporation and the Widnes Corporation.

At the sitting of the Examiners on Tuesday, it was found that Standing Orders had been complied with in the case of the Metropolitan District Railway, the Keighley Corporation, Kingston-upon-Hull Corporation, Leeds Corporation, North-Eastern Railway and London and District Electricity Supply Bills. A non-compliance was found in regard to certain portions of the London County Council Tramways Bill.

Morecambe Corporation Tramways Bill.—On Tuesday the above Bill came before the Examiners of Standing Orders in the House of Commons, and as there was no appearance on behalf of the promotors, presumably the Bill will be withdrawn. The powers sought were to acquire two tramways now worked by the Morecambe Tramways Co. by animal traction, and to reconstruct them for electrical working, and the estimates provided for £44,327 for reconstruction and £10,000 for electrical feeder cables, &c. There was also a clause to enable the Corporation to supply electrical energy for tramway purposes.

East Metropolitan Power-Gas Supply Bill.—This Bill should have come before the Examiners on Tuesday, for proof of compliance with Standing Orders, but there was no appearance, which points to the fact that the Bill will not be proceeded with. The Bill, which is promoted by the British Coalite Co., sought powers to supply in West and East Ham, Barking and part of Woolwich, and there were clauses which enabled the company to supply gas in bulk to local authorities or companies for the manufacture and generation of electricity.

Electric Zinc Smelting.—At a recent meeting of the Tristate Mining Association an interesting paper was read by F. T. Snyder on the comparative costs of zinc smelting for two plants, the one using retorts and the other an electric stack furnace. Each plant has an annual capacity of 25,000 tons, and operates under equivalent conditions. The first cost of the present type of retort plant, including land, buildings and machinery, but without working capital, is some £80,000. The equivalent first cost of the electric stack plant, including steam-driven electric generating machinery will be substantially the same. Of this, £32,000 is the cost of the stack plant and £40,000 the cost of the electric generating plant. General operating cost items for salaries, depreciation, &c., are about the same in each case. The operating cost of a modern retort plant, burning coal, is taken as 16s. per ton of raw ore, while the labour in an electric stack plant may be kept well under 12s. per ton on account of the greater compactness of the plant. As to fuel, a regenerative retort plant will burn 4,200 lb. of coal per ton of raw ore, and of this 600 lb. are used for roasting. An electric stack furnace takes 1,200-H.P.-hours of electricity per ton of raw ore, which require about 1,800 lb. of coal. The coal required for roasting is also one-half. The saving is substantially 1 ton of coal per ton of ore. With a retort plant 800 lb. of reduction material will be used per ton of raw ore, but with the electric plant only 200 lb., which at normal prices effects a saving of 2s. per ton. Summing up the total differences, a saving of 10s. per ton is ensured with the electric plant. The increased recovery with the stack plant of zinc, at normal prices amounts in addition to some 16s. per ton of ore. With the electric stack plant iron in the zinc ore improves the operation, and, in fact, has to be added if absent. With this furnace, the lead in the ore is reduced and saved separately at the same time as the zinc. This makes it practicable to do rougher concentrating work, and let the lead go in with the zinc, taking out the gangue only. With zinc concentrates containing 3 per cent. of lead, 2½ per cent. will be saved in electric stack smelting and lost in the retort furnace, an item representing some 8s. per ton of metal. Lime is required in the charge of the stack furnace, and is permissible in the roasting operation, as a low sulphur content is not required. With limy ore this saves the penalty to the mine-owner. It also makes a saving of zinc, as with no lime penalty, close work is not so imperative, and less zinc is lost in the mill tailings. This item may reach 6s. per ton. Summing up these economies of metals in the electric stack plant over the results of the retort plant, the total saving is 30s. per ton of shipping ore. This, with the reduction of operating expense, makes a net difference of £2 per ton of ore.

An American Boiler Test.—A pamphlet comes to hand of a test on a Rust water-tube boiler by Mr. W. Kent, which is of interest, because the boiler was supplied with a Dutch oven furnace. In itself the boiler is simple, and consists of two sections, each, consisting of two plain drums joined by vertical tubes. The two sections stand vertically with a vertical wall between them from which and the side walls project baffles of brick to compel the gases to pass along the tube area. The furnace is built out at the base of one section. The gases ascend, pass over the top of the central wall and down amongst the tubes of the other section, and then away to the chimney. Thus, the gases travel parallel with the tubes on a 10-hours' run, burning 17 lb. of dry coal per square foot of grate, and evaporating 3·63 lb. of water per square foot of heating surface, the boiler efficiency was 75·85 per cent., with coal of 13,428 B.TH.U. dry value, carrying 14 per cent. of ash. The grate was 68 sq. ft. in area, and the heating surface was 3,350 sq. ft., the atio being 1 : 50 nearly.

On another test, when burning coal at the rate of 38 lb. dry coal per square foot per hour, the efficiency of 69·17 per cent. was obtained, the calorific value of the dry coal being 13·202 B.TH.U., and its ash 13·29 per cent. The coal was almot of semi-bituminous quality; the chimney draught in each case was 1 to 1·1 in., and the ashpit draught 0·17 and 0·32. In one case the oven-fire draught was 0·32; in the other, 0·72. The gases escaped at 503° F., and at 718° F. It will be noticed that per square foot of heating surface, the evaporation was 7·26 lb. in the second test, when the boiler did double its rated horse-power. Assuming the output of steam to be reasonably dry, the results show that the firebrick furnace will give good results in economy.

Finsbury Technical College O.S.A. — From the editor, Mr. W. J. Tennant, we have received a copy of the "Old Students' Association Magazine," which has recently been brought out. This first issue contains a portrait supplement of Dr. M. O. Forster, F.R.S., the first president of the O.S.A., 1906-7, who also contributes a short article on the Association. There is a grumble by "One Who Was" about the curriculum of an engineering student, who on finding himself "pitchforked into the midst of a big engineering works after a two years' college course, wonders whether he really knows anything at all about engineering." Doubtless very much depends upon the "course" and the "college" that is in question; but to take the opinion of the newly-fledged apprentice on the subject is somewhat foolish. However, the writer means well, though he seems to regard the ideal college training as a kind of apprenticeship preparatory to the actual apprenticeship which follows later. Such a training should be sought in a technical school, not at college. Excellent antidotes to this plaint of failure are found in the next article, by H. MacCallum, and a breezy "greeting" from Prof. Perry which follows. The issue also contains articles by R. G. Blaine, M. de V., R. J. Wallis-Jones, and "Otto," the last-named contributing a valuable essay on an assistant engineer's training. The issue, on the whole, is a very good one, and we wish the new periodical all success.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* ELECTRICAL REVIEW *posted as to their movements.

Central Station Officials.—MR. FRANCIS having elected to remain at Kirkcaldy, the Carlisle T.C. has appointed MR. ALLEN, at present chief assistant to the Plymouth borough electrical engineer, as electrical engineer.

MR. A. E. FIRTH has left the Bradford Corporation electricity works, having been appointed junior assistant engineer under the Keighley Corporation.

Tramway Officials.—MR. J. W. GALLOWAY, of Rochdale, has been appointed to the post of rolling-stock inspector at Halifax.

The employés of the Darwen Corporation electric tramways department held their annual social gathering on January 16th. Councillor Catterall, chairman of the Tramways Committee, presided, and was supported by the Mayor, Mr. R. W. Smith-Saville (the tramways engineer and manager), Mr. F. J. S. Hosken (depôt superintendent), Mr. Stokes (traffic manager), and Mr. J. Stirrup (chief inspector, Blackburn section).

General.—On Saturday, January 18th, at Rothesay Dock Electric Power Station, Clydebank, Mr. Stormont, the electrical engineer, on behalf of the staff, presented MR. H. L. TAYLOR (Messrs. Siemens Bros' representative there), with a silver match-box, cigarette case, and cigarette holder. Mr. Taylor leaves shortly for Stafford.

Obituary.—JOHN MACFARLANE GRAY.—In our last issue it was our regrettable duty to record the death at Edinburgh on Tuesday, the 14th inst., of Mr. John Macfarlane Gray, late Chief Examiner of Engineers to the Board of Trade. Before Mr. Gray entered the Board of Trade, he had had a distinguished career as a marine engineer and inventor. While employed as an engineer at the Vauxhall Foundry, Liverpool, he invented steam steering gear for the *Great Eastern*. Without this invention the steering of the *Great Eastern* would have been impossible. For some years afterwards there was little demand for the invention, but in recent years, when the size of our ships has gradually come up to, and even far surpassed, that of the *Great Eastern*, the actuation of the steering gear by steam or some other form of power has become a *sine qua non*, and a numerous progeny has sprung from the ingenious device which was first evolved by the brain of Mr. Macfarlane Gray. Mr. Gray was a man of great originality and independence, and generally found new ways of looking at any problem which was presented to him. His slide-valve diagram is an excellent example of this mental trait. At a later date Mr. Gray devoted his immense energy and mental ingenuity to the study of thermo-dynamics and theories of the constitution of matter and of the ether. He invented the $\theta\phi$, or temperature-entropy diagram, and made valuable applications of this in explaining the relations between the pressure, volume, and temperature of steam. As an outcome of his studies in thermo-dynamics, he evolved his "ether pressure theory," which was an ambitious attempt to explain the action of the physical universe. He expended much labour in applying his theory to Regnault's experiments on steam, the results being given in a paper on "The Rationalisation of Regnault's Experiments on Steam." Mr. Gray contributed numerous papers to the various societies to which he belonged, and frequently took part in the discussions. He was for many years connected with the Institution of Naval Architects, of which he was made a member of Council in 1880, and a Vice-President in 1904. He was one of the original members of the Institute of Marine Engineers, which, owing to his official position, became widely known and exercised a great influence among sea-going engineers. Mr. Gray was a man with immense concentration and perseverance in his mental pursuits. His freedom and range of play of fancy, and his inventiveness were very high. Most of his mathematical and physical knowledge was self-acquired, and his remarkable natural ability in these sciences suggested that, with a thorough early training, we might have had in him another Maxwell or a Kelvin.

SIR J. LAWSON WALTON.—The late Attorney-General, whose death occurred with so little warning last Saturday morning, appeared, previous to taking up his high position in the present Government two years ago, in many famous trials, both criminal and civil, with which we, in these pages, have no concern, but our readers will doubtless remember cases of electrical interest which he was able to bring to a very satisfactory issue. We may, perhaps, be pardoned if we single out for special reference the very able manner in which he represented the ELECTRICAL REVIEW as counsel in some of our electrical quackery litigation of the year 1893—first, that of Tibbits *versus* Alabaster; secondly, that of Alabaster and others *v.* the Medical Battery Co., Ltd., in which damages were awarded against the defendants for trying to hinder the circulation of the ELECTRICAL REVIEW, in which the Electropathic and Zander Institute, and the Harness belts purveyed there, were frequently criticised. Finally he led for us in the maintenance case of Alabaster and others *v.* Harness and others.

TOM LONDON.—A Reuter despatch from Mombasa says that the body of Mr. Tom London has now been discovered and certain natives have been arrested, as murder is suspected. It will be remembered that on December 19th Mr. London, who was in charge of the T. C. & M. Co.'s *Colonia*, landed at Kilsindini, but had since been missing.

MR. E. J. PHILPOT, who had for many years carried on business as an electrician and electrical contractor at Canterbury, died on January 16th as the result of a motor accident. He was 48 years of age.

CITY NOTES.

Direct United States Cable Co., Ltd.

THE directors' report for the half-year ended December 31st, 1907, states that the revenue, after deducting out-payments, amounted to £58,268, as compared with £60,380 for the corresponding period of 1906, showing a difference of £2,111 against the half-year under review. The working and other expenses for the same period, including income-tax, but exclusive of cost of cable maintenance, amounted to £25,103, leaving a balance of £33,165 as the net profit, making, with £2,516 brought forward from the previous half-year, a total of £35,681. For the corresponding period of 1906, the working expenses and other payments amounted to £25,381. Interim dividends of 4s. per share for the quarter ended September 30th, 1907 (paid October 26th, 1907), and of 4s. per share for the quarter ended December 31st, 1907, payable January 31st, 1908, together amounting to £24,284, have been declared, and after setting aside £5,000 to the reserve fund account, the balance of £6,397 on the revenue account has been carried forward. The reserve fund account has been debited with £5,097 for the cost of cable maintenance, and after being credited with interest on the investments, profit on sale of securities and amount set aside from revenue, now amounts to £501,565.

Harper Electric Piano Co., Ltd.—The directors have declared a dividend at the rate of 10 per cent. on the preference shares for the half-year ended December last.

Phosphor Bronze Co., Ltd.—A petition to the Courts to confirm an alteration in the articles of association is to be heard in London on February 8th. The alterations are in Clause 3 which concerns the objects of the company. The new clause was published in full in a lengthy advertisement which appeared in the *Times* of January 16th.

MARKET QUOTATIONS.

Wednesday, January 22nd.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	88/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal)	per ton	£39 10	..
a ,, ,,	per ton	£30	..
Bleaching powder	per ton	£5 10	..
a Bisulphide of Carbon	per ton	£18	..
a Borax	per ton	£16	..
a Copper Sulphate	per ton	£24	10/- inc.
a Lead, Nitrate	per ton	£31	..
a ,, White Sugar	per ton	£28	£2 dec.
a ,, Peroxide	per ton	£32	..
a Methylated Spirit	per gal.	2/6	..
a Potassium Bichromate, in casks	per lb.	8½d.	..
a Potash, Caustic (75/80 %)	per ton	£20	..
a ,, Chlorate	per lb.	3½d.	..
a ,, Perchlorate	per lb.	9d.	..
a Potassium Cyanide	per lb.	7d.	..
a Shellac	per cwt.	125/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	..
a ,, Chlorate	per lb.	3½d.	..
a ,, Crystals	per ton	£3 5	..
a Sodium Bichromate, casks	per lb.	9d.	..
a ,, Cyanide (basis 100 %)	per lb.	7d.	..
METALS, &c.			
b Aluminium Ingots, in ton lots	per ton	£168	..
b ,, Wire, in ton lots	per ton	£150	..
b ,, Sheet, in ton lots	per ton	£145	..
v Babbitt's metal ingots	per ton	£50 to £125	..
c Brass (rolled metal 2° to 12°) basis	per lb.	7d.	¾d. dec.
c ,, Tube (brazed)	per lb.	9¼d.	..
c ,, ,, (solid drawn)	per lb.	8¼d.	..
c ,, Wire, basis	per lb.	7¾d.	¾d. dec.
c Copper Tubes (brazed)	per lb.	10¼d.	¼d. inc.
c ,, ,, (solid drawn)	per lb.	10¼d.	¼d. inc.
g Copper Bars (best selected)	per ton	£80	£2 inc.
g Copper Sheet	per ton	£80	£2 inc.
g ,, Rod	per ton	£80	£2 inc.
c ,, (Electrolytic) Bars	per ton	£66	£1 inc.
c ,, ,, Sheets	per ton	£83	£1 inc.
c ,, ,, Rod	per ton	£72	£1 inc.
c ,, ,, H.C. Wire	per lb.	8¾d.	..
f Ebonite Rod	per lb.	8/8	..
f ,, Sheet	per lb.	8/-	..
n German Silver Wire	per lb.	1/6½	..
h Gutta-percha, fine	per lb.	5/6 to 6/6	..
h India-rubber, Para fine	per lb.	3/1½ to 3/2	¼d. dec.
i Iron Pig (Cleveland warrants)	per ton	48/-	7½d. dec.
l ,, Wire, galv. No. 8, P.O. qual.	per ton	£15	..
g Lead, English Ingot	per ton	£14 15 to £15	5/- inc.
g ,, ,, Sheet	per ton	£15 19 to £16 4	5/- inc.
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£8 5	..
d Mica (in original cases) small	per lb.	6d. to 1/-	..
d ,, ,, ,, medium	per lb.	2/6 to 4/-	..
d ,, ,, ,, large	per lb.	4/6 to 8/6	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/2	..
p ,, rolled bars & rods	per lb.	1/2 to 1/3	..
p ,, ,, strip & sheet	per lb.	1/2½ to 1/5	..
o Platinum	per oz.	110/-	..
Silicium Bronze Wire	per lb.	10d.	..
Steel, Magnet, in bars		£60	..
q Tin, Block (English)	per ton	£126 to £127	£2 inc.
n ,, Wire, Nos. 1 to 16	per lb.	1/9½	..
p White Anti-friction Metals— "White Ant" brand	per ton	£40 to £60	..
k Zinc, Sh's (Vieille Montagne bnd.)	per ton	£25	..

Quotations supplied by:—

a G. Boor & Co.
b The British Aluminium Co., Ltd.
c Thos. Bolton & Sons, Ltd.
d F. Wiggins & Sons.
e Frederick Smith & Co.
f India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.
g James & Shakspeare.
h Edward Till & Co.
i Bolling & Lowe.
k Morris Ashby, Ltd.
l Richard Johnson & Nephew, Ltd.
m W. T. Glover & Co., Ltd.
n P. Ormiston & Sons.
o Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Co., Ltd.
r W. F. Dennis & Co.

British Aluminium Company, Ltd. — An extraordinary general meeting is to be held on 23rd inst., when a scheme will be submitted to divide each of the £10 conversion shares, created in 1906, into two shares of £5 each, of which one shall be a 7 per cent. preference share, being entitled to a division of profits as from the 1st inst., and ranking in all other respects *pari passu* with the existing 7 per cent. preference shares. The other will be an ordinary share ranking with the existing ordinary shares. The conversion shares that are not fully paid will be divided proportionately.

Metropolitan Railway Co.—The directors recommend a dividend upon the ordinary stock for the past half-year at the rate of 10s. per cent. per annum, carrying forward about £5,500. The dividend on the surplus lands stock will be at the rate of 2¾ per cent. per annum.

Bank Rate.—The Bank Rate was yesterday reduced to 4 per cent.

STOCKS AND SHARES.

Tuesday Evening.

MARKETS are not devoid of cheerfulness, although the buoyancy reported so far this year has received something of a check. The reduction of the Bank last Thursday turned out to have been thoroughly discounted, and the expected improvement in prices did not take place. In fact, there were a good many falls instead of rises. Consols, however, are gaining ground again, and the impression that money will become yet cheaper is responsible for steady advances in many gilt-edged securities. The very satisfactory improvement amongst electricity supply shares continues to be a feature of the markets.

Home Railway stocks are far from being good. No doubt a fair amount of weak speculation sprang up in the opening days of the month, and the public demand having proved less than the buyers expected, the holders of the stock preferred to cut their commitments. Therefore, a weak tone has supervened amongst most of the Ordinary stocks, although the Debenture, Preference and similar securities are steadily adding points to their quotations.

Central London Deferred stock has dropped a point, notwithstanding the recently-announced arrangement between the City and South London and the Central London for through bookings upon both systems. Great Northern and City Preferred shares are again 5s. lower. Districts keep about 10½, but a sharp fall brought Metropolitans down to 39. The dividend on Metropolitan Consolidated is declared at the rate of ½ per cent., and on the Surplus Lands at the rate of 2¾ per cent. These are the same distributions as a year ago, and had been anticipated by the market.

Charing Cross are still the favourites in the newly-awakened interest of the public for electricity supply shares. The Ordinary have put on 7s. 6d., and are nearly up to their par value of £5. Indeed, these shares and the two kinds of Preferences both stand at 4¾. The 4 per cent. Debenture stock has also hardened. County of London Preference rose ¼, and so did St. James' Ordinary and Notting Hill. Metropolitan Ordinary and Preference further rallied. Westminsters have retained their full improvement of last week. Debenture stocks are firm, and the list, as a whole, presents a healthier appearance than it has done for a long time past. The noticeable feature of the movement is, of course, that the best class of London lighting companies' shares are those most wanted.

In passing, it may be observed that gas stocks are also rising, so investors would appear to be paying more heed to illumination issues all round.

Electric Construction Preference went suddenly better. In the market the explanation given for the rise is that there was no justification for the earlier fall. Crompton's have again hardened, and at 1⅛ are ¼ up.

Telegraph descriptions are firm, with a sprinkling of advances. Several stocks and shares recovered the dividends deducted last week. The principal rise has fallen to American Telephone and Telegraph capital stock, which is not only *ex* 2 points dividend, but shows a rise of 4 over and above the distribution, the price being now 112½. Anglo-American Telegraphs are erratic. The dividend declaration is expected to be made on Friday in this week. Direct United States Cable shares remain at 14, but are now *ex.* the 4s. dividend. The report is hardly so good as its predecessor. West Coast of American shares forged ahead again, following up their 7s. 6d. rise with another of 6s. 3d., which left the shares at 1⅛.

West India and Panama Preference are good, and the Eastern group displays general firmness, Cuba Telegraph Preference rose 5s., Globe Telegraph and Trust shares of both kinds are better, but no change has taken place in the Mackay issues.

Tramway shares are very quiet. Calcuttas have recovered their loss, but British Electric Traction Preference are dwindling, though the Debenture stock advanced 2 per cent. Cape Electrics, after being moribund for months, have hardened to 6s. 3d. middle. Westinghouse Debenture changed hands at 44 on Monday, and is marked lower at 40 to 45. Argentine Tramways are virtually unaltered.

Prospectus.—*Langkat Sumatra Rubber Co., Ltd.*—This new company has this week been inviting subscriptions for 31,000 shares of £1 each at par.

Montreal Light, Heat and Power Co.—The directors have declared a dividend of 1½ per cent. on the paid-up capital stock, being at the rate of 6 per cent. per annum for the quarter ending January 31st.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. *	Dividends for the last four years. 1903.	1904.	1905.	1906.	Closing Quotations Jan. 14th.	Closing Quotations Jan. 21st.	Business done week ended Jan. 21st, 1908. Highest.	Lowest.	Rise + or Fall —	Present Yield per cent. £ s. d.
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	Nil	2 — 3	2 — 3	..	..	..	Nil
149,800	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	5 %	5 %	84 — 87	84 — 87	..	..	..	5 14 11
£131,551,400	American Telephone & Telegraph, Cap. Stock	$100	7¼%	7¼%	7¼%	8 %	107 —110	111 —114	113	112½	+4	7 0 4
$53,000,000	Do. Collat. Trust, 4% Bonds, 1 to 28,000 and 53,001 to 78,000	$1000	4 %	4 %	4 %	4 %	86 — 88	86 — 88	..	..	..	4 10 11
660,660	Anglo-American Telegraph	Stock	61s.	2½%	3½%	3½%	57 — 60	56 — 59	58	57½	—1	6 11 4
3,169,670	Do. do. do. 6 % Pref.	Stock	6 %	5½%	6 %	6 %	100 —102	100½—102½	101⅞	100⅞	+ ⅜	5 17 1
3,169,670	Do. do. do. Deferred	Stock	2s.	Nil	½%	1½%	16 — 16½	15 — 15½	16 1/16	15⅜	—1	11 5 10
3,169,670	Do. do. do.	100	..	..	5 %	5 %	99 —102	99 —102	..	..	..	4 18 0
50,000	Anglo-Portuguese Tel., 5 % Mort. Deb. Stock Red.	5	7 %	8 %	8 %	8 %	6¾— 7¼	6¾— 7¼	..	..	..	5 10 4
44,000	Chili Telephone, Nos. 1 to 44,000	Stock	4 %	4 %	4 %	4 %	80 — 84 xd	80 — 84	83	82	..	4 15 3
2,007,680	Commercial Cable Stlng. 500 year 4 % Deb. Sk. Red.	10	0 %	5 %	5 %	5 %	6½— 7½	6½— 7½	7	..	..	6 17 11
16,000	Cuba Telegraph	10	15 %	10 %	10 %	10 %	15½— 16½	15½— 16⅝	..	..	+ ⅛	6 1 8
6,000	Do. 10 % Pref.	5	4 %	4 %	4 %	4 %	3½— 3¾	3½— 3¾	..	..	..	5 14 3
12,981	Direct Spanish Telegraph, Ord.	5	10 %	10 %	10 %	10 %	8¼— 8⅝	8¼— 8⅝	..	..	..	5 14 3
6,000	Do. do. 10 % Cum. Pref.	50	44%	44%	44%	44%	97 —100	97 —100	..	..	..	9 0 0
30,000	Do. do. 4½ % Debs.	20	8 %	8½%	42%	48%	13¾— 14½	13¾— 14½	14	13⅞	..	6 10 9
60,710	Direct United States Cable	100	44%	44%	44%	44%	99 —101	99 —101	..	..	..	4 9 1
57,000	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200, R.	Stock	7 %	7 %	7 %	7 %	131 —136	131 —136	134	131	..	5 2 11
4,000,000	Eastern Telegraph, Ord. Stock	100	8½%	8½%	8½%	8½%	83 — 86	82 — 85	83½	82	—1	4 2 4
2,000,000	Do. 3½ % Pref. Stock	Stock	4 %	4 %	4 %	4 %	99 —102	99 —102	100½	..	..	3 18 6
1,896,706	Do. 4 % Mort. Deb. Stock. Red.	10	7 %	7 %	7 %	7 %	12½— 13	12⅝— 12⅞	12⅝	12⅜	..	5 7 8
300,000	Eastern Extension, Australasia, and China Tele.	Stock	4 %	4 %	4 %	4 %	99½—102½	100 —103	..	..	+ ⅜	3 17 8
752,400	Do. 4 % Deb. Stock	100	4 %	4 %	4 %	4 %	98 —101	98 —101	..	..	..	3 19 8
295,400	East & S. Afric. Tel., 4 % Mt. Db., 1 to 8,000, red. 1909	25	4 %	4 %	4 %	4 %	99 —101	99 —101	..	..	..	15 17 0
200,000	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 8,000	10	5½%	5½%	5½%	5½%	9⅞— 10⅛	9¾— 10⅛	10 3/16	9⅞	+ ⅛	4 16 .
181,127	Globe Telegraph and Trust	10	6 %	6 %	6 %	6 %	12⅞— 13⅛	13 — 13½	13⅛	12 1/16	+ ⅛	4 8 11
181,127	Do. do. 6 % Pref.	10	15 %	24 %	24%	20 %	30 — 32	30 — 32	..	..	..	6 5 0
150,000	Great Northern Telegraph, of Copenhagen	100	4½%	4½%	4½%	4½%	99 —101	99 —101	..	..	..	4 9 1
28,900	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	25	10 %	13 %	13 %	13 %	52 — 55	52 — 55	..	..	..	6 5 0
17,000	Indo-European Telegraph	$100	..	1 %	2 %	3½%	60 — 65	60 — 65	..	..	..	5 7 8
$41,380,400	Mackay Companies Common	$100	..	4 %	4 %	4 %	63 — 68	63 — 68	60½	..	..	5 17 8
$50,000,000	Do. do. 4% Cum. Pref.	1	Nil	Nil	Nil	Nil	3/16— 5/16	3/16— 5/16	15/6	15/-	+ 3/8	Nil
256,127	Marconi's Wireless Telegraph	1	3 %	4 %	5 %	6 %	1⅛— 1⅛	1⅛— 1⅛	..	..	..	4 14 1
72,680	Monte Video Telephone Co., Ltd. Ord.	1	5 %	5 %	5 %	5 %	1— 1	1— 1	..	..	..	5 0 0
96,492	Do. do. do. 5 % Pref.	100	6 %	6 %	6 %	6 %	110 —113	110½—112½	111⅔	111	+ ½	5 6 8
2,225,000	National Telephone, Pref. Stock	100	5 %	5 %	5 %	5 %	107½—109½	107½—109½	108⅔	108	..	4 11 4
2,225,000	Do. do. Def. Stock	10	6 %	6 %	6 %	6 %	11 — 13	11 — 13	..	..	..	4 12 4
15,000	Do. do. 6 % Cum. 1st. Pref.	10	6 %	6 %	6 %	6 %	10 — 12	10 — 12	11 7/16	..	..	4 8 4
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %	5½— 5¾	5½— 5¾	5⅝	5 5/16	..	4 13 0
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %	96½— 98	96½— 98½	97	..	+ ⅜	3 11 1
2,000,000	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	3½%	99 —101	99 —101	100½	100½	..	3 19 8
1,689,598	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	1⅛— 1⅜	1⅛— 1⅜	21/8	..	..	5 17 11
179,313	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6¾%	6¾%	7 %	7 %	1⅛— 1 1/16	1⅛— 1 1/16	..	..	..	5 1 1
50,000	Do. do. do. 6 % Cum. Pref.	1	6 %	6 %	6 %	6 %	1⅛— 1 1/16	1⅛— 1 1/16	..	..	..	4 6 0
100,000	Do. do. do. 4 % Red. Deb. Stock	100	..	..	4 %	4 %	90 — 93	91 — 93	92	..	..	4 0 0
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	10	4 %	4 %	4 %	4 %	97 —100	97 —100	..	..	..	5 0 0
11,889	Reuter's	8	5 %	5 %	5 %	5 %	7 — 8	7 — 8	..	..	..	4 8 3
60,000	Telephone Co. of Egypt, 4½ % Deb. Red.	100	..	..	4½%	4½%	98 —101	99 —102	..	..	+1	4 14 6
3,167	Submarine Cables Trust	Cert.	6 %	6 %	6 %	6 %	124 —127	124 —127	..	..	..	5 14 3
80,000	United River Plate Telephone	5	8 %	8 %	8 %	8 %	6¼— 7	6½— 7	..	..	..	4 15 3
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	4½— 5¼	4½— 5¼	5⅛	..	..	4 15 3
15,609	West African Telegraph, Shares	10	4 %	4½%	4 %	4 %	10 — 10½	10 — 10½	..	..	..	8 16 2
30,008	W. Coast of America, 1 to 30,000 & 53,001 to 53,008	2	Nil	Nil	Nil	2½%	1½— 1⅝	1⅝— 2 1/16	40/7½	31/3	+ 5/16	9 15 2
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	4 %	99 — 99	97 —100	..	..	+1	4 0 0
207,930	Western Telegraph, Ltd., Nos. 1 to 207,930	10	7 %	7 %	7 %	7 %	12¾— 13⅛	12⅞— 13⅛	13⅛	13	..	5 4 8
800,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	97 —100	97⅛—100⅛	..	..	+ ⅜	3 19 7
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	Nil	3/16— 5/16	3/16— 5/16	..	..	..	Nil
34,563	Do. do. 6 % Cum. 1st Pref.	10	7 %†	6 %	5 %	8 %	7⅛— 7⅜	7⅛— 7⅜	7⅛	..	+ ⅛	10 4 10
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	Nil	7¼— 7⅝	7¼— 7⅝	..	..	+ ⅛	Nil
80,000	Do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	5 %	98 — 101	99 —102	99	..	—1	4 18 0

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

270,000	Anglo-Argentine Trams, 10 % Nom. Cum. 2nd Pref., 260,008 to 580,097	5	..	8 %	8 %	8 %	7⅞— 8¼	7⅞— 8¼	8 1/16	7 15/16	..	4 17 0
260,007	Do. 6 % Cum. Prefs., 1 to 260,007	5	5½%	5½%	5½%	5½%	5⅞— 6⅛	5⅞— 6⅛	6⅛	5 15/16	..	4 9 10
266,600	Do. Permanent, 6 % Deb. Stock, 1888	100	6 %	6 %	6 %	6 %	125 —128	125 —128	..	..	..	4 13 9
285,100	Auckland E. Trams, 5 % 1st Mort. Deb. Stock	100	5 %	5 %	5 %	5 %	102 —105	102 —105	..	..	..	4 15 3
880,000	Babcock & Wilcox, 1 to 530,000	1	17 %	20 %	20 %	20 %	3½— 3⅝	3½— 3⅝	..	..	..	5 6 8
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000	1	6 %	6 %	6 %	6 %	1 1/16— 1 1/16	1 1/16— 1 1/16	..	..	..	3 16 10
88,000	British Aluminium, Ord., 2,001 to 40,000	5	..	7 %	7 %	7 %	3¾— 4¼	3¾— 4¼	78/1½	76/3	+ ¼	7 15 7
40,000	Do. do. 7 % Cum. Pref.	5	Nil	7 %	7 %	7 %	4⅛— 5⅛	4⅛— 5⅛	5 3/32	5	— ⅛	6 16 7
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	6 %	6 %	6 %	4⅛— 5⅛	4⅛— 5⅛	..	..	..	5 11 8
20,000	Do. do. 4 % Funding Certs.	5	..	4 %	4 %	4 %	3½— 4¼	3½— 4¼	8 /8	80/-	..	4 14 1
258,000	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	100 —103	100 —103	102½	102	..	5 13 5
800,000	Do. do. 5½ % Loch Leven Debs.	100	..	..	..	5½%	97 —100	97 —100	99	..	..	5 10 0
400,000	British Columbia E. Rail Def. Ord. Stock	100	6 %	6 %	6 %	6 %	125 —128	125 —128	..	..	..	4 13 9
800,000	Do. 5 % Pref. Ord. Stock	100	5 %	5 %	5 %	5 %	105 —109	105 —109	126¼	..	—2	4 11 9
800,000	Do. 5 % Cum. Perp. Pref. Stock	100	5 %	5 %	5 %	5 %	101 —105	99 —103	..	..	—1	4 17 1
238,000	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	4½%	4½%	4½%	4½%	99 —102	100 —103	..	..	+1	4 7 3
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	4½%	4½%	4½%	4½%	100 —103	99 —102	..	..	—1	4 8 3
133,301	British Electric Traction	10	6 %	6 %	3 %	Nil	1⅜— 1⅝	1⅜— 1⅝	31/3	27/6	..	Nil
161,437	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	6 %	5 — 5⅜	5½— 5⅝	5½	97/6	— ⅛	11 3 4
1,448,653	Do. do. 5 % Perp. Deb. Stock	Stock	5 %	5 %	5 %	5 %	90 — 93	92 — 95	94½	93	+2	5 5 3
410,178	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	4½%	4½%	4½%	69 — 74	69 — 74	70	..	..	6 1 7
100,000	British Insulated and Helsby Cables	5	8 %	8 %	8 %	10 %	6¼— 6⅞	6½— 7	..	..	+ ⅛	7 2 10
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	5⅝— 6⅛	5⅝— 6⅛	5 15/16	5⅝	..	4 18 0
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%	100 —103	100 —103	..	..	..	4 7 5
212,000	British Thomson-Houston 4½ % 1st Mort. Debs.	100	4½%	4½%	4½%	4½%	85 — 89	85 — 89	..	..	..	4 18 11
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	6 %	Nil	Nil	Nil	⅝— 1	⅝— 1	15/-	..	..	Nil
1,016,353	Do. do. 4 % Mort. Deb. Stock	100	4 %	4 %	4 %	4 %	40 — 50	40 — 45	44	41	+2½	8 17 10
50,000	Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	Nil	1/16 — 1/8	1/16 — 1/8	..	..	..	Nil
50,000	Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	Nil	14/6 to 15/6	14/6 to 15/6	..	..	..	Nil
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	2½%	Nil	0— 1/32	0 — 1/32	..	..	..	Nil
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	Nil	1/32— 1/16	1/32— 1/16	..	..	..	Nil
125,000	Do. do. 4½ % Perp. Deb. Stock	Stock	4½%	4½%	4½%	4½%	83 — 86	83 — 86	..	..	..	5 4 8
125,000	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	63 — 66	63 — 66	..	..	..	6 16 4
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	3 %	4 %	3 %	3 %	4⅛— 4⅜	4 7/32— 4 9/32	..	..	+ 1/32	3 4 0
40,000	Do. do. "A" 6 % Cum. Pref., 1 to 40,000	5	6 %	6 %	6 %	6 %	4⅛— 5⅛	4⅛— 5⅛	..	..	..	5 14 3
27,500	Do. do. "B" do., 1 to 27,500	5	6 %	6 %	6 %	6 %	4⅛— 5⅛	4⅛— 5⅛	..	..	..	5 14 3
13,200	Do. do. 5 % Deb. Stock	100	5 %	5 %	5 %	5 %	105 —115	105 —115	..	..	..	4 6 11
190,000	Do. do. 5 % 2nd Deb. Stock	100	5 %	5 %	5 %	5 %	101 —104	101 —104	..	..	..	4 16 2
187,610	Calcutta Trams, 1 to 187,610	5	6 %	8 %	8 %	8 %	6⅛— 6⅝	6⅛— 6⅝	6⅝	6⅜	..	5 18 6
80,000	Do. 5 % Cum. Pref., Nos. 1 to 29,330	5	..	..	..	5 %	4⅛— 5⅛	4⅛— 5⅛	..	..	..	4 13 0
350,000	Do. 4½ % 1st Deb. Stock	100	4½%	4½%	4½%	4½%	99 —103	99 —103	101	..	..	4 7 5
35,000	Callender's Cable Construction shares	5	12½%	12½%	15 %	15 %	9½— 10⅛	9⅜— 10⅛	9⅝	..	..	7 6 4
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅛— 5⅝	5⅛— 5⅝	5⅝	..	..	4 6 11
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	104 —106	104 —106	..	..	..	4 4 11
491,222	Cape E Trams., 1 to 491,222	1	10 %	5 %	Nil	Nil	1/16— 1/8	1/16— 1/8	..	..	+ 1/16	Nil
450,000	Castner-Kellner Alkali, 1 to 450,000	1	4 %	4 %	6 %	8 %	1⅛— 1⅜	1⅛— 1⅜	26/-	25/9	..	5 16 4
294,988	Do. do. 4½ % 1st Mort. Deb. Stock	100	4½%	4½%	4½%	4½%	101 —104	101 —104	..	..	..	4 6 7
911,568	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %	65 — 68	65 — 68	67	65½	..	5 17 8
544,216	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	4 %	84 — 86	84 — 86	85	84½	—1	4 13 0
544,216	Do. do. Def. do.	Stock	4 %	4 %	4 %	4 %	44 — 47	43 — 46	44½	44	—1	4 14 0
1,480,000	City and South London Railway	Stock	2¾%	2½%	1½%	2½%	44 — 46	44 — 46	45½	45	..	4 12 5

* Unless otherwise stated, all shares are fully paid. † A period of nine months. ‡ From Manchester Share List.

Continued on next page.

SHARE LIST OF ELECTRICAL COMPANIES.—(*Continued.*)

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—(*Continued*)

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years.				Closing Quotations Jan. 14th.	Closing Quotations Jan. 21st.	Business done week ended Jan. 21st, 1908.		Rise + or Fall —	Present Yield per cent.
		*	1903.	1904.	1905.	1906.			Highest	Lowest.		£ s. d.
85,000	Crompton & Co., Nos. 1 to 85,000	3	2½%	2½%	2½%	5 %	1⅞ — 1⅞	1¹¹/₁₆ — 1⅞	84/4½	..	+ ⅛	8 6 8
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	94 — 97	94 — 97	..	..	..	5 3 1
260,000	Dick, Kerr & Co., 1 to 260,000	1	..	10 %	10 %	10 %	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..	7 5 5
805,000	Do. do. 6 % Cum. Pref., 1 to 805,000	1	6 %	6 %	6 %	6 %	1 — 1⅛	1 — 1⅛	..	..	..	4 16 0
294,150	Do. do. 4½ % Deb. Stock	100	4½%	4½%	4½%	4½%	99 —102	99 —102	..	..	..	4 8 3
60,000	Dublin United Trams. (1896), 1 to 60,000	10	5½%	6 %	6%	6 %	13 — 14	13 — 14	..	..	..	4 5 9
59,987	Do. 6 % Pref. between 1 and 60,000	10	6 %	6 %	6 %	6 %	12⅜ — 13⅜	12⅜ — 13⅜	..	..	..	4 7 8
99,261	Edison & Swan Utd., "A" shs., £3 pd., 1 to 99,261	5	Nil	2½%	4½%	4½%	1⅝ — 1⅞	1⅝ — 1⅞	18/9	..	..	11 7 6
17,189	Do. "A" shares, 01—017,189	5	Nil	2½%	4½%	4½%	1½ — 2⅛	1½ — 2⅛	..	..	..	8 6 9
319,475	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	78 — 81	78 — 81	..	..	..	4 18 9
72,220	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	87 — 90	87 — 90	..	..	..	5 11 1
112,100	Electric Contruction, 1 to 112,100	2	4 %	Nil	Nil	Nil	⅛ — ¼	⅛ — ¼	..	..	..	Nil
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	7 %	7 %	7 %	Nil	1⅛ — 1⅜	1⅛ — 1⅜	..	..	+ ½	Nil
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	4 %	5 %	5 %	5 %	7⅞ — 8¼	7⅞ — 8¼	..	..	..	6 1 3
200,000	Do. do 4 % Mort Deb.	Stock	4 %	4 %	4 %	4 %	89 — 92	89 — 92	..	..	..	4 19 11
78,000	Gt. N. & City Rail. Pref. Ord. "A" 4 %, 1 to 78,000	10	3 %	4 %	4 %	4 %	1¾ — 2	1¾ — 1⅞	..	..	..	17 15 6
96,000	Greenwood & Batley, 7 % Cum. Pref.	10	7 %	7 %	7 %	7 %	10¼ — 10⅜	10¼ — 10⅜	..	..	..	6 10 8
80,000	Do. do. 5 % Mort. Debs.	100	5 %	5 %	5 %	5 %	102 —103	102 —103	..	..	..	4 17 1
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	15 %	15 %	15%	15 %	10¾ — 11⅛	10¾ — 11⅛	11⅛	10⅜	..	6 10 0
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	4½%	4⅞ — 5⅛	4⅞ — 5⅛	98/9	..	..	8 19 1
150,000	Do. do. 4½ % Mort. Deb. Stock	Stock	4½%	4½%	4½%	4½%	104½—106⅛	104½—106⅛	..	..	..	4 4 6
50,000	India-Rubber, Gutta-percha & Telegraph Works.	10	10%	5 %	10%	10 %	14⅛ — 15⅛	14⅛ — 15⅛	..	..	..	6 9 0
87,500	†Liverpool Overhead Railway, Ord.	10	1⅜%	1⅜%	Nil	Nil	1⅛ — 1⅜	1⅛ — 1⅜	..	..	— ⅛	Nil
10,000	† Do. do. Pref., fully paid	10	5 %	5 %	5 %	5 %	8 — 8½	8 — 8½	..	..	..	5 17 8
600,070	London United Trams. (1901), 1 to 50,007	10	8 %	6 %	8 %	8 %	6¼ — 6⅜	6¼ — 6⅜	..	..	..	4 8 11
999,930	Do. do. 60,008 to 100,000	10	8 %	6 %	3 %	8 %	6¼ — 6⅜	6¼ — 6⅜	..	..	..	4 8 11
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	5 %	5 %	5 %	5 %	7⅞ — 8⅛	7⅞ — 8⅛	8	..	..	5 17 8
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	4 %	4 %	4 %	4 %	80 — 84	80 — 84	83⅛	81⅞	..	4 15 3
314,016	Metropolitan Electric Trams., Defd.	1	Nil	Nil	Nil	Nil	1/16 — 1/8	1/16 — 1/8	..	..	..	Nil
500,000	Do. do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	1/8 — 3/16	1/8 — 3/16	17/-	16/3	..	5 6 8
350,000	Do. do. 4½ % Deb. Stock Red.	100	..	4½%	4½%	4½%	91 — 94	91 — 94	..	..	..	4 15 9
245,500	Potteries E. Trc.	1	5 %	5 %	4 %	4 %	1/16 — 1/8	1/16 — 1/8	..	..	..	7 2 3
245,500	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	3/8 — 1/2	3/8 — 1/2	..	..	..	6 13 4
245,000	Do. 4½ % Deb. Stock	100	4½%	4½%	4½%	4½%	93 — 96	93 — 96	..	..	..	4 18 9
37,350	Telegraph Construction and Maintenance	12	20 %	15 %	15 %	15 %	28½ — 30½	28½ — 30½	30	28⅜	..	5 7 2
150,000£	Do. 4 % Ded. Bds., 1 to 1,500 Red., 1909	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..	3 18 5
599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	5 %	5 %	5 %	35 — 39	36 — 40	..	..	+1	12 10 0
66,666	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	5	3 %	Nil	Nil	..	1 — 1⅛	1 — 1⅛	..	..	..	Nil
66,666	Do. 6 % C.P., 30,001 to 80,000 & 125,001 to 141,666	5	6 %	Nil	Nil	..	3¼ — 3⅜	3¼ — 3⅜	..	..	..	Nil
246,574	Do. 4 % 1st Mort. Deb. Stock	100	4 %	4 %	4 %	4 %	72 — 77	72 — 77	..	..	..	5 1 3

ELECTRICITY SUPPLY COMPANIES.

14,000	Bromley (Kent) E.L. & P,. 1 to 14,000	5	5 %	5½%	5½%	5½%	4⅝ — 5⅛	4⅝ — 5⅛	..	..	..	5 7 4
70,000	Do. do. 4½ % 1st. deb. stock	100	4½%	4½%	4½%	4½%	95 — 98	95 — 98	..	..	..	4 11 10
29,798	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	10 %	10 %	10 %	10%	7 — 8	7 — 8	..	..	..	6 5 0
10,202	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	7 — 8	7 — 8	..	..	..	4 7 6
336,876	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	97 —100	97 —100	..	..	..	4 0 0
80,000	Charing Cross and Strand Electricity Supply	5	8 %	8 %	5 %	5 %	4⅛ — 4⅝	4⅛ — 5	96/8	90/-	+ ⅜	5 0 0
80,000	Do. do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	4½%	4⅛ — 5	4⅛ — 5	..	..	..	4 10 0
80,000	Do. "City Undertaking" 4½ % Cum. Pref.	5	4½%	4½%	4½%	4½%	4⅝ — 4⅞	4¼ — 4⅝	98/9	90/-	— ¼	4 14 9
427,400	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	96 — 99	97 —100	..	..	+1	4 0 0
49,436	Chelsea Electricity Supply, Ord.	5	5½%	6 %	6 %	4½%	3⅝ — 4⅛	3⅝ — 4⅛	80/-	..	..	5 5 11
175,000£	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	100 —103	100 —103	101	..	..	4 7 5
70,595	City of Londo Elec. Lighting, Ord. 40,001—110,595	10	5 %	6 %	6 %	6 %	10 — 11	10 — 11	10½	10⅜	..	5 9 1
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	11¼ — 12½	11¼ — 12½	..	..	..	4 18 0
400,000£	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	120 —123	120 —123	..	..	..	4 1 4
800,000	Do. 4½ % 2nd. Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	4½%	97 —100	97 —100	99½	..	..	4 10 0
40,000	County of Durham Electrical Power, Ord.	5	4 %	£8 7 0	4 %	4 %	3½ — 4¼	3½ — 4¼	..	..	..	4 14 1
50,000	Do. do. do. 5 % Pref.	5	5 %	5 %	5 %	5 %	4⅜ — 4¾	4⅜ — 4¾	..	..	..	5 2 7
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4½%	5 %	5 %	6½ — 7⅛	6⅝ — 7⅛	..	..	..	6 13 4
40,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	6 %	10¼ — 11	10⅜ — 11⅛	10⅜	..	+ ⅛	5 7 10
400,000£	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	103 —106	103 —106	106	..	..	4 4 11
400,000	Do. do. 4½ % 2nd. Deb. Stock	Stock	4½%	4½%	4½%	4½%	95 — 98	95 — 98	97	..	..	4 11 10
80,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	4 %	Nil	3/8 — 7/16	3/8 — 7/16	..	..	..	11 0 0
80,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	3 %	1½ — 1⅝	1½ — 1⅝	..	..	..	10 0 0
350,000	Do. do. 4½ % 1st Mort. Deb. Stk.	100	4½%	4½%	4½%	4½%	70 — 80	70 — 80	..	..	..	5 12 6
10,000	Folkestone, 1 to 10,000	5	5½%	5½%	5½%	5½%	4½ — 5	4½ — 5	..	..	..	5 10 0
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	..	5 %	5 %	5 — 5½	5 — 5½	..	..	..	4 10 11
90,000	Do. 4½ % 1st Deb. Stock	100	4½%	4½%	4½%	4½%	96 — 99	94 — 97	..	..	−2	4 12 9
13,000	Hove, 1 to 13,000	5	8½%	8½%	9 %	9 %	6⅝ — 6⅞	6⅝ — 6⅞	..	..	..	6 10 11
21,000	Kensington and Knightsbridge Electric Ord.	5	12½%	12 %	10 %	10 %	8 — 9	8 — 9	..	..	..	5 11 1
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	96 — 99	96 — 99	..	..	..	4 0 10
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	3 %	4 %	4 %	1¼ — 1⅜	1⅜ — 1⅜	..	..	..	6 16 2
70,000	Do. do. do. 6 % Pref.	5	6 %	6 %	6 %	6 %	4⅜ — 4⅞	4⅜ — 4⅞	..	..	..	6 3 1
874,395	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	89 — 93	90 — 94	92	..	+1	4 15 9
200,000	Metropolitan Electric Supply, 1 to 100,000	5	8⅜%	10 %	10 %	8 %	5⅜ — 6⅛	5⅞ — 6⅜	6⅛	6⅛	+ ⅛	6 5 6
76,121	Do. 4½ % Cum. Pref. 1—71,106	5	4½%	4½%	4½%	4½%	4⅛ — 5⅛	4⅛ — 5⅜	5 1/16	5 1/16	+ ⅛	4 3 9
220,000£	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	100 —104	101 —105	..	..	+1	4 5 9
250,000£	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	3½%	85 — 90	85 — 90	..	..	..	3 17 9
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	4½%	95 — 98	95 — 98	..	..	..	4 11 10
87,500	Newcastle-on-Tyne, 1 to 87,500	5	8 %	8 %	8 %	8 %	6¼ — 6⅜	6¼ — 6⅜	..	..	..	5 18 6
87,500	Do. 5 % Pref., 1 to 87,500	5	5 %	5 %	5 %	5 %	5 — 5⅛	5 — 5⅛	..	..	..	4 10 11
10,852	Notting Hill Electric Lighting	10	6 %	7 %	7½%	7½%	11 — 12	11½ — 12½	..	..	+ ½	6 2 5
20,000	Oxford, 1 to 96 and 407 to 20,310	5	6½%	7 %	7 %	7 %	5⅛ — 6	5⅜ — 6	5⅝	..	..	5 16 8
50,000	Do. 4 % Deb. Stock	100	4 %	4 %	4 %	4 %	95 — 97	93 — 95 xd	..	..	−2	4 4 3
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	12½%	10 %	7⅜ — 8⅛	7⅜ — 8⅜	..	..	+ ½	5 14 3
20,000	Do. do. 7 % Pref. 20,061 to 40,060	5	7 %	7 %	7 %	7 %	6½ — 7⅛	6⅜ — 7⅛	6⅞	..	..	4 13 4
150,000£	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	3½%	85 — 90	85 — 90	..	..	..	3 17 9
12,000	Smithfield Markets Electric Supply, Ord.	5	4 %	4 %	4 %	Nil	⅛ — 1¼	⅛ — 1¼	..	..	..	Nil
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	71 — 75	71 — 75	..	..	..	5 4 4
65,000	South London Electricity Supply, Ord.	5	3 %	4 %	4 %	3 %	2½ — 3	2½ — 3	..	..	..	5 0 0
120,000	South Met. Elec. Lt. & Power, Ord.	1	Nil	Nil	2½%	2½%	⅞ — 1	⅞ — 1	..	..	..	3 6 8
117,968	Do. do. 7 % Pref.	1	7 %	7 %	7 %	7 %	1⅜ — 1⅝	1⅛ — 1⅝	22/6	..	..	3 14 8
200,000	Do. do. 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	4½%	100 —103	101 —104	..	..	+1	4 6 7
80,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	5 %	1½ — 2⅛	1½ — 2⅛	..	..	..	12 10 0
50,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	2 — 2⅛	2 — 2⅛	47/6	40/-	..	10 0 0
200,000	Do. do. 4½ % 1st Mort. Db. Stk. Red.	100	..	4½%	4½%	4½%	90 — 93	90 — 93	..	..	..	4 16 9
110,000	Westminster Electric Supply, Ord.	5	13½%	14 %	18 %	12 %	8½ — 9⅛	8½ — 9⅛	9⅛	8⅞	..	6 6 4
81,979	Do. do. 4½ % Cum. Pref. (Original 5 %—Red. to 4½ % from 31st Dec., 1905)	5	5 %	5 %	5 %	4½%	5 — 5⅛	5 — 5⅛	5⅛	5¹/₁₆	..	4 1 10

* Unless otherwise stated, all shares are fully paid. † Quotations on Liverpool Stock Exchange.

Bank rate of Discount 6 per cent. January 16th, 1908.

ROLLING MILLS AND WINDING ENGINES OPERATED BY THURY MOTORS.

The electrical driving of rolling mills and winding plant has attracted so much attention of late, that no apology is needed for placing before our readers an interesting system, which has been brought to a high degree of perfection by M. Thury, on the well-known principle of constant current at variable pressure, the success of which has rendered it familiar to everybody. The great advantages of electrical driving are simplicity, reliability and efficiency. The system herein described not only gives all the advantages above-mentioned, but does so to a remarkable degree.

Description.—In all electrical systems devised for economically operating rolling mills, winding engines, and other plant where the fluctuations of load are considerable, and where the work is of necessity intermittent, use has been made of the fly-wheel as a storer of energy. This is at once the best and most logical method, and consequently the cheapest, as by its use the prime movers need only be large enough to cope with the mean load, and by this means not only are they kept practically uniformly loaded, but every advantage can be taken of condensing, when steam engines are used. The brush movement is controlled by a special regulator which has stood the test of time, and is sensitive and quick enough in action to regulate the generators over the widest variations in load. The movement of the brushes on the motors when hand-controlled is effected by a single lever, but in the case of large motors it is accomplished by means of oil under pressure. This system is well known, and has given the greatest satisfaction in hydraulic turbine control, the turbine valves being generally operated by this means.

The motors should be coupled to the winding drums or rolls either directly or through suitable gearing, and when necessary, couplings of the Zodel-Raffard type can be inserted to prevent shock at the moment when the torque changes in sign. Diagram No. 1 shows the general arrangement of the plant, whilst diagram No. 2 shows the system applied to several machines in the same circuit.

From these it will be seen that the only plant outside the power house consists of the actual motors themselves. No fly-wheel sets have to be placed adjacent to the mills or winders. Such fly-wheels as are necessary are common to all the motors on the system. Consequently the saving in cost when more than one motor drive is needed is considerable, and the amount of space saved, especially in rolling-mill work, is very valuable.

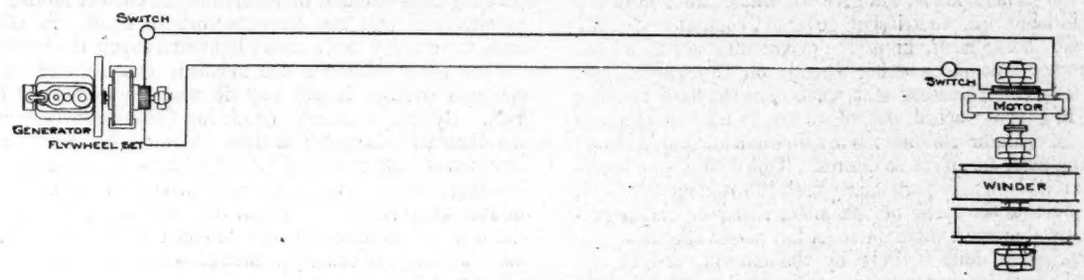


Diagram 1.—Thury System: Single Winder.

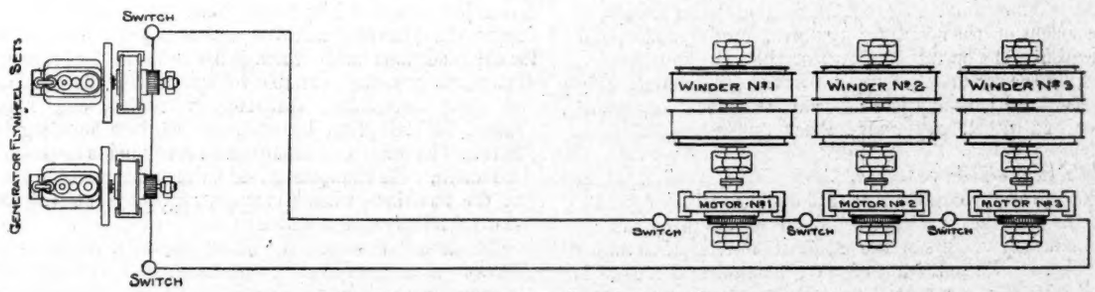


Diagram 2.—Winders with Motors in Series.

In the Thury system the prime movers, fly-wheels and direct-current generators are all located in the power house. The latter, of course, have to be capable of giving the full output demanded by the motors, whilst the former need only be of sufficient size to supply energy to the fly-wheels at the average rate. The fly-wheels are constructed to run at very high peripheral velocities, and store up a large amount of energy, which is used for driving the generators during the peaks and equalising the demand on the prime movers.

To enable a fly-wheel to give out at periods of greatest demand the energy stored in it during periods of least load, a reduction in its speed is necessary. The Thury system accommodates itself to all speeds, and as a result the fly-wheel becomes an accumulator of greater value and higher efficiency in the Thury than it does in any other system.

With steam engines the torque hardly changes for a speed variation of 10 to 15 per cent., consequently the fullest use can be made of this property, with considerable advantage.

From the foregoing it will be seen that in principle the Thury system possesses many advantages, and a study of its details will strengthen this impression.

As is well known, the system employs a constant current at a voltage depending on the load. The generators and motors are series-wound, and are controlled by brush movement alone. No rheostats or any such starting devices are needed, and no losses due to such apparatus are

The power house can be situated at any suitable spot for operating any number of machines; the voltage of transmission being high enables this to be done without making the cable or overhead conductor costs in any way excessive. In the event of several mills or mines being operated off the same system, the amount of electrical plant situated at each mill or mine will be actually less than would be needed for operating direct-current and alternating-current motors under ordinary every-day conditions.

Load.—It may be observed that there is no necessity to confine the supply of power developed in a high-pressure direct-current series power house to the operating of special machines.

The supply being at constant current, constant-speed machines can be operated, and current transformed by means of motor-generators to alternating or ordinary constant-pressure direct current for general distribution, lighting and small motors. This means a further saving due to the use of this system, as by it there is no transformation of current needed for the work which is of the greatest importance and magnitude.

By the use of brush regulators this transformation presents no difficulties; the speed of the constant-speed plant is automatically maintained by a piece of apparatus no more complicated than the governor of an ordinary steam engine.

The excess of power required by the mills or winders being

supplied by the fly-wheels, the output of energy by the prime movers is more or less constant; consequently the transforming plant needed for ordinary distribution is unaffected by the variations of load on what may be called the main circuit.

Operation.—As the generators are automatic in their action, we need only consider the actual winding and rolling-mill motors themselves, leaving out the safety gear, brakes, depth indicators, &c., all of which are necessary with every form of winding, and in no way dependent on the form of motor used for doing the work. The actual operation requires only *one* lever for moving the brushes of the motor.

When the machine is at rest, the brushes are kept in the neutral position, the motor under these conditions having no tendency to move in either direction; in fact, it cannot be moved, consequently the brakes need never be applied unless the stop is of considerable duration, either when the motor is in circuit with the mains, and the current flowing through it, or when it is short-circuited.

To operate the machine the brushes have only to be moved forwards or backwards, depending on the direction of rotation required, when the armature at once begins to move. This brush movement regulates the speed, which is entirely under the control of the operator, who, having only one lever to manipulate, can give his whole attention to the work in hand. A centrifugal governor, connected directly with the motor itself, keeps the maximum speed to a predetermined amount by acting directly on the brushes, and thus keeps the speed constant when once the fixed running value has been reached, but, of course, in no way interferes with the operator running his machine at a lower speed when winding men, &c., if he so desires. This device, simple and sure in its action, is particularly useful in rolling-mill work, as it prevents the speed of the motor rising beyond a predetermined amount when the ingot has passed the rolls.

Braking is done entirely by the current, and at any desired speed, by simply bringing the brushes back to their neutral position.

With Thury motors, the torque, as in all series motors, is independent of the speed for any given brush position, and consequently the operation of putting the rolls into motion or taking the strain on the ropes in winding is done smoothly and evenly without any jerking or appreciable absorption of power, and without any undue shock to the generators or motors.

Efficiency.—The over-all efficiency of the plant is high, and compares favourably with that obtained with any other system. The fact that constant speed in the prime movers is unnecessary permits of the smallest possible prime mover being used. The efficiency of the generators and motors is equal to that of any large direct-current plant (in fact, it is greater, reaching 97 per cent. in motors and generators of the larger sizes, 3,000-5,000 H.P.), owing to the liberal design and, consequently, small internal losses. The voltage being considerable permits of great economy in the first cost of the conductors, and the absence of any transformers, starting rheostats, field-exciting motors, and other sources of loss due to lagging currents, slip in motors, &c., brings the whole down to a figure low in value and easily calculated.

The maintenance is low, and the burning-out of the motors even by improper handling is impossible. The use of fly-wheels provides an accumulator of energy low in first cost and cheap to maintain, whilst the simplicity of the plant reduces the number of machines to a minimum.

Safety.—In no system is there a greater factor of safety. When in circuit the motors are controlled by the current, and can hold the load indefinitely without the aid of brakes. If the prime movers fail, the motors are either short-circuited by the system or on their own switches. In neither case is it possible for them to be run away with by the load when used for winding. The current value being constant and the machines all series wound, there are no small windings to break or become disconnected, the conductors are always of sufficient size to make them quite safe from mechanical damage, and no machine has ever to withstand more than the pressure for which it is designed. There are no fuses to blow or switches to cause open circuits, whilst, in the event of necessity, the full energy stored in the fly-wheels can be used to run the machines until the whole system is brought to a standstill, when it is in a state of equilibrium. This is only possible with a system using direct current, as the question of frequency does not enter into the problem.

In addition, all the usual mechanical devices are available, such as are in use in connection with this work all over the world, so that there need be no grounds for any objection on the score of "safety."

Cost.—In first cost, as in the cost of operation, the system compares very favourably with any other in existence. The amount of plant required is reduced to a minimum, and in cases where more than one set of motors are used for winding, rolling, or both, the cost of generating and fly-wheel plant is very low. All such plant being common to the whole of the motors in use, its total horse-power must of necessity be less than in cases where fly-wheel sets are installed for each individual drive.

Thus one engine, fly-wheel and generator can operate several plants so long as the fly-wheel effect is sufficient, and prime movers aggregating, say, 1,000-1,200 H.P. can operate satisfactorily three or four winders or rolling mills absorbing 9,000-12,000 H.P.

In rolling-mill work, so long as there are no winders in circuit, a great saving in power can also be made, and operating costs reduced, by regulating the current flowing in the circuit to suit the heaviest work in hand. In other words, the current strength can be altered to suit the heaviest sections being rolled at the moment, and reduced to a minimum without in any way affecting the working of the plant. By this means the ohmic loss (C^2R) can be reduced, and eliminated altogether at times of long stoppages, such as are common and necessary in all rolling-mill work during reheating, &c., by reducing the current to zero. This control can be effected outside of the power house altogether, and can be exercised by the foreman in charge of the shops, but only, of course, in such establishments as generate their own power.

Conclusion.—In conclusion, it may be said that the system just described is by far the simplest that exists, and the absence of any but mechanical regulation makes it most suitable for the conditions under which it has to work. The principle of constant current at variable voltage makes the machines and their connections mechanically robust, and makes damage to the plant by abuse or careless handling impossible. The worst a workman can do is to run his machines to a standstill. He cannot overload them and so damage them, and the machines, when so stopped, cannot be started until the overload has been removed.

The absence of switchgear makes the men confident and fearless. A mistake in switching can do no harm other than shutting down the plant momentarily. Any such mistakes are purely local, and do not affect other motors in the system. Mistakes, if made, being local, are not cumulative in their effect. If one man overloads his machine and shuts it down, he does not disturb the whole system or produce trouble elsewhere: in fact, he does the reverse, as by stopping his own plant by neglect and bad operation he merely permits it to consume sufficient voltage to overcome its own internal resistance; he thus drops the voltage of the system without in any way affecting the value of the current strength, reducing the load in the power house and leaving a bigger margin of reserve power for the other plants in the circuit.

The value of such a condition cannot be over-estimated when motors of anything from 1,000 to 10,000 H.P. are being dealt with, and this fact alone, apart from any of the other advantages enumerated, makes the system particularly suited for the class of work considered in this article.

Simplex Announcements. — Messrs. Simplex Conduits, Ltd., announce that from February 1st the discount to the trade from Simplex conduit prices will be considerably increased. The 1908 edition of the company's pocket book was completely exhausted after Christmas, and reprints will be issued in a few weeks' time. Readers who still desire copies should make application to the publicity department in Charing Cross Road, W.C. We have received one of the firm's large show cards, upon which are set out prices of conduits and fittings. The top and bottom rollers are sample lengths of their ordinary grade conduit.

THE HOPKINSON TEST AS APPLIED TO LARGE INDUCTION MOTORS.

By N. PENSABENE-PEREZ.

The following will describe a complete Hopkinson test as applied to four large induction motors, made by the Electric Construction Co., Ltd., at their Bushbury Works. This kind of test presents many interesting points, both from scientific as well as practical points of view. Before entering into the details of the test, perhaps it will be of some interest to establish a general diagram for induction motors with Hopkinson connections, with the purpose of giving a clear insight into the electrical phenomena taking place in the two machines. When two induction motors having pulleys of different diameters are belted together, and their stators connected to the same supply, they start up as ordinary induction motors until the machine which runs faster, reaching synchronism, becomes a generator and sends energy back to the other machine, which acts as a motor. It is clear that the equilibrium will be established when the torques of the two machines are inversely proportional to their speeds. In the following, while the primary resistance is taken into consideration, its effect of reducing (motor) or

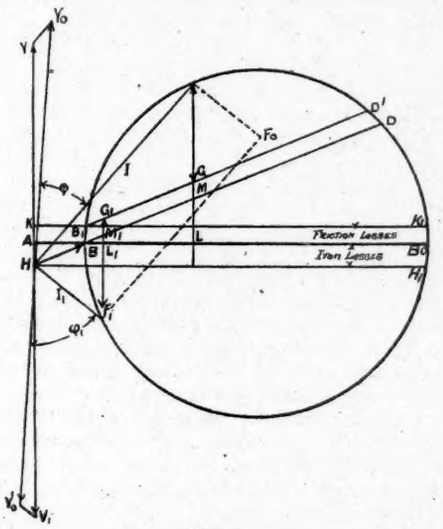


Fig. 1.

increasing (generator) the flux and the magnetising current is neglected in the diagram. The vector H V represents the voltage applied on the motor when deducting vectorially from the supply voltage H V_0, the primary resistance drop V V_0, and H V_1 represents the E.M.F. for the generator, which is the vectorial sum of the voltage H $V_0' = -$ H V_0 and the resistance drop V_0' V_1. The vector H B represents the magnetising current, and A B_0 is the theoretical short-circuit current, $\frac{A\,B}{B\,B_0} = \sigma$, being the leakage factor. The primary currents are H F and H F_1, and the secondary currents B F, B F_1. The points F_1 F are moving on the circle shown in diagram which has its centre on the straight line A B_0. The straight lines K K_1, H H_1 are being traced parallel to A B_0, and at a distance representing, in the scale of powers, the friction and the iron losses respectively for each machine. If the point at which the motor would start, without outside secondary resistance, is D, the straight line B D is the locus giving the secondary losses. (See an article by the author in the *Electrical Engineer* of January 12th, 1904.) In our case, for instance, the segments M L, $M_1 L_1$ would represent the secondary losses of the motor and generator respectively. The motor and the generator slips are—

$$S_1 = \frac{M\,L}{L\,F}, \quad S_2 = \frac{L_1\,M_1}{M_1\,F_1}.$$

If we trace the straight line B′ D′ parallel to B D, we can say that the motor output will be given by F G, the generator input by $F_1 G_1 = F G$. The kilowatt input of the motor is $1{\cdot}73\ V_0\ I \cos \phi$, and the electrical output of the generator $1{\cdot}73\ V_0\ I_1 \cos \phi_1$.

From this diagram it can be seen that while in the induction motor the primary copper resistance and the iron losses increase the value of the power factor, the opposite is to be said for the asynchronous generator; therefore, an induction motor working as a generator with a certain

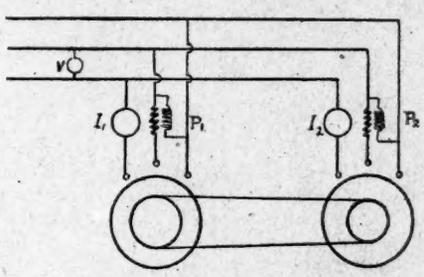


Fig. 2.—Two E.C.C. 100-B H.P. Three-phase Motors connected for Full-load Test.

current input has a power factor lower than when working as a motor and taking the same current. The current supplied by the main is the vectorial sum of the currents taken by the two machines; this is represented in the diagram by the segment H F_0, and it is of about the same magnitude as the motor current. This constitutes the weak point of this kind of test, because it will be necessary not only to supply the excess of power for the losses of the two machines, but also to have the alternator supplying the energy much larger than the motor to be tested; in fact, it must supply about the kilowatt input of the same at a very low power factor.

As will be seen later, the diameters of the pulleys plus the thickness of the belt are related to the slips of the machines and the slip s′ of the belt as follows:—

$$\frac{D_g + b}{D_m + b} = \frac{1 - s_1}{1 + s_2}\,(1 - s').$$

If we want to test the motor at 25 per cent. overload, and assume a combined efficiency of about 0·84, we calculate the slips of the motor and the generator to be respectively:— $s_1 = {\cdot}022$ and $s_2 = {\cdot}019$, so that if the belt slip is estimated to be 2 per cent. of the motor speed we get—

$$\frac{D_g + b}{D_m + b} = \frac{{\cdot}978}{1{\cdot}019} \times {\cdot}98 = {\cdot}945.$$

This relation is satisfied if we take $D_m = 30\frac{1}{4}$ in.; $D_g = 28\frac{9}{16}$ in., and $b = \frac{7}{16}$ in.

This point being settled before belting the machines together, we can find the iron and friction losses by the well-known method of measuring the light-load watts when the machine is running at synchronous speed with the rotor circuit closed and when this is suddenly opened; we find in this way:—Iron losses, 1,800 watts; friction losses, 900 watts.

In connection with the belt losses, we must distinguish between the losses due to the rigidity of the belt and the losses due to the slip of the same.

For determining the first losses, we took one reading with both machines belted, one having the rotor open, and another reading with both machines running light without belt. We had, in the first case, 6 KW. input for both machines, in the second case 5·4 KW.; then:—rigidity of belt losses = 600 watts.

The other losses can be found in the following manner:—If v_1, v_2 are the peripheral speeds of the two pulleys and F is the tension transmitted by the belt, it is clear that the losses due to slip of belt are: F $(v_1 - v_2) =$ F v_1 $(v_1 - v_2)/v_1$.

F v_1 being the output of the motor and $(v_1 - v_2)/v_1 = s'$, the belt slip in terms of the motor speed, we can say that the losses due to the slip of the belt are in watts 746 · B.H.P. s′.

Now it is easy to see that—

$$s' = 1 - \frac{D_g + b}{D_m + b}\frac{N_o}{N_1},$$

and as $N_1 = (1 - s_1)\,N$, $N_2 = (1 + s_2)\,N$, N being the synchronous speed, we get—

$$s' = 1 - \frac{D_g + b}{D_m + b}\frac{1 + s_2}{1 - s_1}.*$$

The determination of the slip for the slip-ring type motors is very simple and accurate. In each case the machines are fitted with gear for short-circuiting the slip-rings and lifting the brushes. We found that even when the short-circuiting plug was in, a millivoltmeter would oscillate sensibly when put across two slip-rings.

The following table gives two readings representing the results of many tests. The first refers to the motor with slip-rings short-circuited by the plug and the generator running with the brushes on; in the second case, both machines are with plug in. As can be seen, the slip in the generator with the brushes on is considerably increased and the power of both machines about 20 per cent. less than in the second case.

By applying the above formula we find that the belt slip in both cases is about 2 per cent. of the motor speed.

Motor.								Generator.						
Volts. V.	Frequency. ~	Amps. I_1	KW. output. P_1	Rotor cycles per min C_1	R.P.M.	Rotor ? slip. $s_1 = \frac{C_1}{60\sim}$	Cos ϕ	Amps. I_2	KW. output. P_2	Rotor cycles per min C_2	R.P.M.	Rotor slip. s_2	Cos ϕ	Remarks.
3,000	25·15	18	86	32·5	493	·0215	92	15	69	38·5	518	·0255	88·6	Short-circuiting plug—"in" motor only.
3,030	24·7	21·3	102·5	36·3	480	·0244	91½	17·2	82·5	29	502	·0195	91·3	Short-circuiting plug—"in" motor and generator.

Assuming the efficiency of the motor in the two cases to be ·92 and ·91 respectively, the losses of the belt due to slip are—

$$86 \times \cdot92 \times \cdot02 = 1\cdot65 \text{ KW.}$$
$$102\cdot5 \times \cdot91 \times \cdot02 = 1\cdot87 \text{ KW.}$$

so that we can say finally—

belt loss at full load = 2,250 watts
„ 1·25 „ = 2,470 „

In connection with the determination of the efficiencies of the motor and the generator, there is, as in every Hopkinson test, a certain amount of uncertainty, due to the fact that the two machines work at different loads. By supposing the constant losses to be equal in the two machines, we can easily arrive at the following formula, which will be found accurate enough for practical purposes—

$$p_1 = \frac{(p - 2w)}{1 + \left(\frac{I_2}{I_1}\right)^2} + w,$$

where p_1 is the power wasted in the motor, w the constant losses, I_1 I_2 the stator currents in the motor and generator, and p the total power wasted in the two machines, which is the difference of the two wattmeter readings P_1 P_2, less belt losses.

By applying this formula for the second reading, we arrive at—

Motor efficiency at 100 B.H.P. = 92 per cent.
„ „ 125 „ = 91 „

The power factors of the motor and generator are indicated in the table.

Wolfram (Tungsten) Lamps in France.—It is announced that a French company will shortly be formed in Paris for the industrial utilisation of the Austrian patents for the Wolfram lamp. The Industrial Wolfram Lamp Co., of Buda-Pesth, and the German Incandescent Gas Light (Auer) Co., of Berlin, will participate in the new undertaking, which is to have a share capital of £108,000.

* This formula is very little affected even by a considerable error in the determination of the primary frequency.

SUB-STATION SWITCHGEAR.

By W. PLEASANCE.

It is very often the case that in sub-stations located at distributing points in an electricity supply system, the dimensions are so cramped for economy in excavating costs, that insufficient room is left for the proper placing of the switching and circuit-interrupting gear. This is more particularly the case in sub-stations which have grown in capacity, due to the extension of the systems which they feed. The result is an excessive amount of confusion, and possibly a breakdown on the supply due to bad switching.

In deciding the type and arrangement of the switchgear to be installed, consideration should be given to the question of the permanence or otherwise of the gear. If one or two transformers only are to be installed in a sub-station designed for a large capacity, it may be possible to employ temporary gear well spaced, but if a sub-station is to be equipped to its full capacity, it will pay to make a thoroughly good job at the very commencement, before any cables are made alive.

In deciding the type and position of switchgear, more especially for high pressure, the writer is very strongly of the opinion that under no circumstances whatever should there be any difficulty in getting at any connection on the board. This would seem almost a platitude, but it is a fact that switchboards for sub-stations are often made up with back connections by makers who should know better. If there is to be sufficient room left at the back of the board to work with safety in such a confined position, it is evident that a very large amount of valuable space is taken up. In the case of extra-high-tension switchboards this is, perhaps, unavoidable, but for ordinary 2,000-volt supply, such as is largely used for city service, the boards should be fixed close to the wall by means of insulated bolts, or else cellular switchboards of the Ferranti type may be used.

Ample room should be left in front of high-tension switchboards in sub-stations, inasmuch as it is within the knowledge of every practical mains man having experience of small fuses working on circuits containing induction supplied by heavily-fused feeders, that a fuse which is playfully called by the makers (who do not have to use them) a 25-ampere fuse, is as often as not called upon to break on an absolute short-circuit. In doing this it generally blows to pieces, and in these days of employers' liability the question of risk is perhaps worth a passing thought.

The question of a reliable fuse is one of the utmost importance, and although the relative merits of the different types of fuse cannot be discussed in this article, it should be borne in mind by everyone designing sub-station fusing arrangements that with the generating sets of large capacity now to be found in most central stations, the volts do not drop to a temporary short-circuit as they used to do on smaller supplies. For this reason fuses which through many years of trial on small systems have obtained a name for reliability are proving themselves to be somewhat dangerous on the larger systems, inasmuch as the arc started by their rupture is maintained by the potential difference, and is liable to spread. Even if it is prevented from affecting adjacent operations of the board, the arc often melts the terminals and renders the re-fusing of the circuit a matter which occupies considerable time. The importance of this point is shown by the modern tendency to include in switchboards controlling main feeders, a more expensive type of current interrupter, having automatic cut-outs operating oil-break switches.

Where a board is made up of switch fuses mounted upon

slate slabs, which is a very usual and flexible method of forming sub-station switchboards, it should be borne in mind that the fuses should be kept as far apart as the chamber allows, and all connections should be accessible from the front. A safe method is to fix all the inner high-tension fuses at such a level that they cannot be conveniently reached without using a wooden platform, which may be insulated and kept dry by being placed near or over the transformers. Fuses on the outers being at earth potential may be placed below and made easily accessible.

A simple and cheap method of arranging the board in the manner mentioned above is given in the figure, where two feeders are shown arranged for independent supply, and also having a means for coupling up one to the other. It will be seen that if the board is arranged on the wall of the sub-station in the manner shown, the circuits become their own diagram. With suitable labels the switchboard

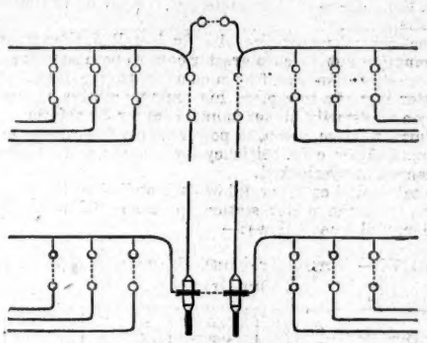


Diagram of Connections.

attendant can tell at all times what is the condition of supply at each sub-station, and what switch fuses must be put in or withdrawn to make any desired connection.

In the low-tension distributors the same separation must be carried out as in the high-tension feeders, and an easy means of finding out any drop on the feeders is to put a low-voltage lamp (say 5 volts) across the two inner bars. This would, of course, burn out in case of a short on either system, and in order to prevent the lamp exploding it must therefore have small fuses in series with it. The low-tension bars should be kept at such a distance from the high-tension gear that any risk of the low-tension network acting as an earth on the high-tension may be avoided as far as possible.

Although the above hints appear to imply a considerable amount of restriction upon the design of sub-stations, a restriction which will in many cases be severely felt owing to the seemingly narrow limits of space available, yet it will be seen that they are the minimum which can be demanded in order to render the sub-station free from the unenviable distinction of being a death trap.

PROCEEDINGS OF INSTITUTIONS.

Cost of Electrical Power for Industrial Purposes.

By John F. C. Snell, Member.

(Abstract of paper read before the Institution of Electrical Engineers *at London and Dublin, January 9th; and Glasgow, January 14th,* 1908.)

The author suggests that the following economical axioms apply to electrical supply:—

1. There is generally a critical load factor and size of plant within which no outside supply can hope to compete with a user's local plant.

2. There is a real limit to the economical radius of distribution from any power station—whatever the pressure of transmission, or whether by underground cables or overhead lines. This radius is much less than is usually advanced by power company promoters.

3. Minimum outlay of capital is indispensable in power supply, and can only be obtained in the power house by the centralisation of large units. But this can be neutralised in any particular case, and the capital per kilowatt raised beyond the critical value, by attempting transmission over too great a distance.

4. Successful power supply depends upon—

(*a*) The geographical positions of the user and supplier, and

(*b*) The resultant diversity factor arising from multiplicity of industries. In the districts where the industries are all practically of one nature, the diversity factor will be almost nil.

The competition of the older-established rival, gas, must be met by improvements in, and the greater economy of, metallic filaments, or other new types of lamp, rather than by the cheapening of the cost of production.

The effect of power supply superadded to lighting supply must of necessity be to reduce the general cost of production, because of the greater resultant diversity factor and consequent improved load factor, and in this country probably 2·0d. per unit may eventually be reached as an average cost of lighting units. The price of lighting must always be considerably in excess of average power prices, both because of its lower load factor and also of the greater cost of low-tension distribution systems and requisite service connections. This reduction of price, however, cannot be compared with the importance of a probable reduction of energy per candle-power from 4 watts to, say, 1·5 watts.

Table I sets forth the cost at various load factors of gas engines supplied with town gas, suction gas engines, oil engines, and small local steam plants from 20 to 100 h.p. with generators and auxiliaries. These figures have been obtained from actual users, and the author has taken great pains to ensure that the figures are reliable. On the one hand they are not merely test figures, which afford no real criteria of the commercial working of such plants; nor, on the other, are they figures of obsolete engines, which it would be unfair to take as a basis.

TABLE I.—Ascertained Cost of Power per Unit Generated for Independent Installations up to 100 h.p.

Annual load factor.	Equivalent hours per annum.	Town gas at 2s. per 1,000 cb. ft.	Suction or producer gas.	Oil.	Steam.	Average costs.
Per cent.		d.	d.	d.	d.	d.
10	876	1·423	1·520	1·286	1·322	1·388
15	1,314	1·210	1·270	0·972	1·031	1·121
20	1,752	1·090	1·040	0·813	0·876	0·954
25	2,190	1·007	0·904	0·715	0·806	0·879
30	2,628	0·944	0·812	0 650	0 705	0 778
35	3,066	0·892	0·744	0·600	0·646	0·720
40	3,504	0·844	0·694	0·563	0·598	0·675
50	4,380	0·791	0·625	0·511	0·542	0·617
60	5,256	0 745	0·576	0·475	0·498	0·574
70	6,132	0·706	0·540	0·448	0·460	0·538
80	7,008	0·670	0·514	0·426	0·429	0 500

The author has taken town gas at an average price of 2s. per 1,000 cb. ft.; and in the case of suction or producer gas engines, anthracite coal at 22s. per ton, or small peas at 10s. per ton; and oil at 42s. 6d. per ton. In the figures water is taken at an average price of 6d. per 1,000 gallons; repairs and lubricating oils are taken from actual figures; and depreciation and interest on capital outlay are taken throughout at 10 per cent. These are the real figures with which manufacturers debit themselves, although it is fair to point out that in nearly every case there is no proportionate charge for supervision or general establishment charges, or for rating. Attendance is frequently not debited to the cost of power, and, therefore, on all points the figures given are decidedly fair to these sources of power, and are even somewhat unfair to electricity supply.

Table II sets out comparative figures for larger and less frequent installations of 100 to 500 h.p.

In the final column of each of the two tables the average results of these figures are given, with which comparisons are made later with the electrical schedule of charges.

TABLE II.—Ascertained Cost of Power per Unit Generated for Independent Plant from 100 to 500 h.p. Installed.

Annual load factor.	Equivalent hours per annum.	Suction or producer gas.	Oil.	Steam.	Average costs.
Per cent.		d.	d.	d.	d.
10	876	1·273	1·007	1·086	1·122
15	1,314	0·944	0·778	0 811	0·844
20	1,752	0·760	0·656	0·673	0·696
25	2,190	0·670	0·584	0·590	0·615
30	2,628	0·596	0 536	0·534	0 555
35	3,066	0·540	0·498	0·494	0·511
40	3,504	0·502	0·469	0·464	0·478
50	4,380	0 447	0·430	0·421	0 433
60	5,256	0·406	0·404	0·393	0·401
70	6,132	0·377	0·382	0 373	0·377
80	7,008	0·358	0 366	0·357	0·360

Turning to the general smaller power users within towns, there is no question that it is possible to supply these successfully from a central source, as none of these works are likely to exceed the running hours of, or the load factor from, a saw mill and joinery works when the annual hours are 2,700 and the load fairly constant; and it has been demonstrated that the latter works can be supplied economically from a central source, and at a cheaper rate than it can be generated by local plant. In

each case of small power supply the author has found it quite easy to compete successfully with local plant, whether steam or gas driven, when each case is carefully tested and dealt with. Moreover, in works of this nature, space is of the utmost importance, and the ability to switch the outside supply on or off at will constitutes a very great boon to the user.

In Sunderland, at the time of the last census for which the author was responsible, and omitting the large engine works and shipyards, there were 587 motors, representing a total horse-power of 1,634, or an equivalent of 1,220 KW. The maximum demand on the station plant was only about 500 KW. There was thus a diversity factor of 2·4, the total units for the year being 404,999, or 332 per kilowatt installed. This represented a consumption of 810 units per kilowatt demanded for this particular load, and was thus under an average load factor of 10 per cent.

Table III will be of value as giving statistical information of the horse-power which may be estimated for works of various kinds.

TABLE III.

Description of works.	H.P. installed.	Number of persons employed.	H.P. per capita.	Annual units.	Units per capita per annum.
Corn mill	378	43	87·9	—	—
Printing (daily papers)	118	32	3·70	15,770	493
Saw mills	190	84	2·26	50,780	604
Steel-rolling mills ...	712	448	1·59	87,117	194
Mineral waters ...	40	32	1·25	10,483	327
Engine and boiler works	485	412	1·18	—	—
Engine and boiler works	750	1,020	0·75	1,031,892	1,012
Glass merchants ...	10	11	0·90	—	—
Coppersmith and foundry	120	199	0·60	12,172	61
Printing (general)	37	69	0·53	21,249	308
Printing (general) ...	8	16	0·50	5,564	347
Laundries (average of several)	10·8	40	0·27	25,054	626
Shipyard	2,099	1,874	1·12	700,000	373
Shipyard	477	446	1·07	198,000	444
Shipyard (with compressors)	6,900	5,564	1·24	2,980,000	536
Paper mill	1,820	410	4·43	—	—

It is interesting to note the relation of the maximum demand in works to the motors installed, though such figures are difficult to obtain, as manufacturers are not generally inclined to give this information. The following particulars are, therefore, somewhat limited.

TABLE IV.

Description of works.	1. H.P. of motors installed.	2. H.P. of transformers installed.	3. Maximum demand. H.P.	— Ratio $\frac{3}{1}$.	— Ratio $\frac{3}{2}$.
Shipyard	1,576	1,200	900	0·76	0·57
Engine works ...	5,538	3,200	2,400	0·57	0·43
Printing	37	—	37	—	1·00
Saw mills... ...	179	200	140	1·12	0·78

There is an enormous scope in this country for electrical applications among all classes of works. In the preparation of particulars for the recent London County Council Power Bills, the author and his colleagues ascertained that in the area of Greater London alone there are factories utilising altogether some 400,000 H.P., while in the evidence brought forward in support of the Administrative Company's Bill, 1906, this figure was given as 535,742 H.P., of which only 29,053 H.P. was then supplied from electrical undertakings. In most of these it would obviously pay the consumer and be in the interest of London and of the nation that these works should be electrified. In course of time this is bound to be. If Greater London were cleared of factory chimneys, coal dust, and ash wagons, and if mechanically propelled vehicles replaced horse vehicles, there would result an enormous change for the better in the physical conditions of life. Moreover, a cheap supply of power would assist to prevent the migration of power users and the consequent reduction in rateable value—a factor which reacts unfavourably on the remaining inhabitants.

A modern power station of important magnitude and favourably situated can now be equipped completely for £12 or £13 per kilowatt installed. One cannot imagine that this figure is likely to be reduced materially. A transmission system in which the cables are designed to allow for diversity of loads supplied over a large area could be laid down also for £12 per kilowatt supplied; thus the all-round cost of an electrical installation is some £25 per kilowatt, excluding transformers.

The author's experience, obtained in providing and equipping a large number of sub-stations, has been as follows:—

TABLE V.—COST OF SUB-STATIONS.

—	Kilowatts installed.	Kilowatt demand.	Cost of buildings, plant and switchgear.	Cost per KW. installed.	Cost per KW. demand.
Transformers.	150	100	£501	£3·34	£5·01
	900	600	1,557	1·74	2·59
			Average ...	£2·54	£3·80
Rotary converters.	650	400	£3,238	£4·98	£8·09
	1,000	750	5,553	5·55	7·40
	1,400	1,150	5,968	4·26	5·19
			Average ...	£4·93	£6·89

In new ground, of course, it is in the interest of every one concerned to use the static transformers, not only because of their lower capital cost, but also because of the minimum space required by them, the absence of attendants, and the saving in running stores and repairs.

If direct-current motors are already installed, then a rotary sub-station must be put in at a greater cost to both supplier and user. It then becomes a matter for calculation to the latter whether it will better pay him to replace his existing motors by three-phase, or to pay a necessarily higher annual sum for transformed and converted current. Here, again, in power supply the difference between an all-round 85 per cent. efficiency for rotaries and 95 per cent. for statics cannot be overlooked.

The total capital cost per kilowatt installed at the power house, therefore, from the power station up to and including the user's sub-station, will be as follows:—

TABLE VI.—COST OF STATIONS, TRANSMISSION SYSTEMS, AND SUB-STATIONS.

—	Capacity of sub-station.	Cost of power house per KW.	Cost of transmission system per KW.	Cost of static sub-station per KW.	Total.	Equivalent cost at 1·66 diversity factor.
Transformers	100-250	£13	£12	£3 33	£28·33	£18·23
	250-1,100	13	12	1·75	26·75	16·75
				Average	£27·54	£17·54
Rotary converters.	250-500	£13	£12	£5·20	£30·20	£20·20
	500-1,500	13	12	4·26	29·26	19·26
				Average	£29·73	£19·73

These are, however, not the real figures to take when fixing a schedule of charges, because of the influence of diversity factor. The following statistics may be useful:—

TABLE VIa.

—	Total kilowatts installed.	Maximum load observed.	Ratio.	Diversity factor.
Engine works ...	1,574	750	0·50	2·00
Engine works ...	1,090	434	0·40	2·25
Shipyard	310	200	0·66	1·50
Shipyard	950	450	0·47	2·12
Shipyard	357	175	0·50	2·00
Dock cranes, &c. ...	223	56	0·25	4·00
Saw mills	135	88	0·65	1·50

Obviously the capital cost per available kilowatt at the power station depends very much on the diversity factor, for the figure which may be taken as the assessable value of a power house and transmission system in the one case is £25 ÷ 1·25, or £20; and in the other case, £25 ÷ 1·66, or £15. Thus the total capital cost of plant, including a static transformer sub-station, will be either £22·54 or £17·54, and the total cost of a rotary sub-station £24·73 or £19·73, according to size.

The capital charges represent an additional 5 per cent. for the rotary over the cost of static sub-stations, without counting the addition to standing charges from attendance or from stores, &c., required by the former type or the less efficiency of rotary sub-stations.

It is of little use straining to reduce the capital outlay per kilowatt on the power house and distribution system, if one is going to sink an additional £2 or £3 per kilowatt on rotary sub-stations, so that there can be no doubt as to the wisdom of applying static sub-stations to all industrial purposes, wherever possible; and it is useless designing a highly efficient power house and transmission system if one throws away 10 per cent. at least in a sub-station.

The severest handicap to power supply from existing London and provincial stations—whether administered by companies or municipalities—is, in the majority of cases, their present high capital cost per kilowatt. It is true that with each extension this figure is

reduced; still, it will be found very difficult, especially in the case of London undertakers, to reduce their total much below £60 per kilowatt, or, in the case of large provincial stations, to reduce their capital much below £40 per kilowatt, or smaller stations to £50, taking into account all existing capital outlay.

This is where the modern power company comes in with the benefits of latest electrical practice, much cheaper buildings, larger and cheaper units of plant, and, generally, an altogether lower cost per kilowatt. Even with a power company, however, there is a danger that the capital, while minimised in the power house, may be unduly raised by the cost of transmission over too great a distance.

The present capital expenditure per kilowatt on London municipal systems averages £93, and London company stations £103; while the present expenditure on provincial municipal stations is £70·8 and provincial companies £90.

The power user is being supplied by certain undertakers at the expense of their lighting consumers, who are paying an unduly high rate for their supply, or, in the case of certain London municipalities, too high a price for public lighting. This system may do very well where there is only a small amount of power to be given, and where the proportionate revenue is only a small fraction of the gross receipts; but let there be a big increase in the amount of power supplied at the same rates (and despite its effect in the general reduction of generating costs), it will be found then that the total receipts are not commensurate with the total costs, and the result will be an unsuccessful undertaking.

That there is only one way in which to deal with the London problem must be obvious to all engineers—that is, through some means, a large power station must be erected at a minimum cost, which, without prejudicing the present capital involved in the existing undertakings, will enable electricity to be supplied for all purposes at considerably less rates than now obtain. The capital sunk in existing undertakings cannot, of course, be ignored; it constitutes a dead-weight upon electrical supply in London, which will remain until this original capital shall have been redeemed. That cannot be for several years yet, and therefore the only compromise is to provide this supplementary low-cost station to co-operate with and assist those already in operation.

Some London municipalities have very foolishly contented themselves by merely putting aside a sinking fund on a 42-years' basis, well knowing that their plant could not possibly exist for so long a time. It will certainly be admitted that 25 years is the maximum period which engineers would be wise to allow as the equated life of their plant. Such municipalities have, therefore, a good deal to make up for past years, and they simply cannot put themselves in a sound financial position and at the same time offer their power users such a low scale of charges as will promote a large revenue from the sale of electricity for power. They, again, can only carry out the duties imposed upon them by their orders by a wise co-operation with some central scheme.

In the larger provincial municipal stations, allowing for a diversity factor of 1·66, the average rate that could properly be charged for, say, a 20 per cent. load factor consumer is 1·16d., whereas a power company ought to be able to supply such a consumer successfully at not more than 0·8d., or a reduction of 30 per cent. In the case of the smaller provincial stations, the results are very much the same. It must not be overlooked, however, that the larger districts will almost certainly have a higher diversity factor, and thus the author is probably wrong to assume the same coefficient in both cases.

TABLE XII.—Newcastle Power Co.

Load factor.	Average cost of production, 1907.	Real cost for power supply, 1·66 D.F.
10 per cent.	2·31d.	1·49d.
15 „	1·62d.	1·07d.
20 „	1·28d.	0·86d.
30 „	0·98d.	0·65d.
40 „	0·76d.	0·55d.
60 „	0·58d.	0·44d.
80 „	0·50d.	0·39d.

Take the case of the Newcastle Power Co., which at present is the only one operating over a large area, and on the scale on which it is expected power companies will work. Table XII gives the real cost of production based on the 1907 figures. Side by side is the power scale of charges based on 1·66 diversity factor. This company has an expenditure of £59·6 per kilowatt installed, of which the cost of the stations has been about £33 per kilowatt; mains and sub-stations, &c., £26. It is interesting to note that the plant installed in sub-stations amounts to about 35,000 KW., supplied by generating plant installed at the station with a total capacity of 20,000 KW. Now, it cannot be said that even this company, having so large a capital expenditure involved and operating on such a big scale, is entirely satisfactory in its finances with a depreciation and reserve account amounting to only 1·07 per cent. for the year. The question arises on such an undertaking whether undue expenditure has not been made upon the transmission system.

The author read a paper in 1904, which dealt with the question of transmission distances in this country, and then showed that at a pressure of 10,000 volts the economical distance for transmitting a load of 1,500 KW. was only 11 miles, where the displaced local station cost £20 per kilowatt.

Assuming that every 100 KW. installed at the power station will supply 166 KW. outside, and taking the cost of the power station at £12 per kilowatt, or £7·2 per effective kilowatt supplied, so far as capital is concerned the effective radii of transmission in miles are as follows:—

Table XIII.

Kilowatt.	Voltage.	Local station costing per kilowatt.				
		£20.	£25.	£30.	£40.	£50.
		Miles.	Miles.	Miles.	Miles.	Miles.
500	6,600	3·7	5·3	7·0	10·3	13·8
1,000	11,000	5·8	8·5	11·2	16·5	22·0
1,500	11,000	7·8	11·5	15·0	22·0	—
1,500	15,000	8·5	12·4	16·2	—	—
2,000	20,000	9·7	14·2	18·5	—	—

These distances, of course, only refer to a comparison between a supply from a central source and local plants installed within factories which usually cost from £20 to £25 per kilowatt.

TABLE XIV.—Estimated Charges from Bulk Supply Undertakings.

Annual load factor.	I. London County Council, 1907. Estimated average charges.			II. London County Council, 1907. Maximum prices.		III. Administrative Co., 1906. Maximum prices.	IV. Newcastle Real cost based on 1907 figures at 1·66 D.F.
	(a) E.H.T.	(b) T. Alt.	(c) D.C.	(a) T. Alt.	(b) D.C.		
Per cent.	d.	d.	d.	d.	d.	d.	d.
10	1·002	1·159	1·453	1·738	2·179	1·50	1·49
15	0·728	0·839	1·042	1·258	1·562	1·16	1·07
20	0·591	0·679	0·836	1·019	1·254	1·02	0·86
25	0·508	0·583	0·713	0·875	1·069	0·94	0·74
30	0·454	0·519	0·631	0·779	0·946	—	0·65
35	0·414	0·474	0·572	0·710	0·858	0·81	0·60
40	0·385	0·439	0·528	0·659	0·792	0·75	0·55
50	0·344	0·391	0·466	0·587	0·699	0·72	0·49
60	0·317	0·359	0·425	0·539	0·638	—	0·44
70	0·297	0·337	0·396	0·505	0·594	—	0·42
80	0·282	0·319	0·374	0·479	0·561	0·64	0·39

Transmission by overhead lines would still further increase these radii, of course, but there is still much difficulty and great expense in obtaining the necessary easements for high-tension lines in this country.

Table XIV sets out the estimated charges of various power companies. In the first column are given the estimated average charges which were proposed in the London County Council (1907) Bill, Column I*a* being for extra-high-tension untransformed energy at the consumer's terminals, Column I*b* for transformed alternating current at any pressure, and Column I*c* for transformed and converted direct current at any pressure. In the next column are set forth the maximum prices under this Bill; in Column III the maximum price proposed by the Administrative Co. of 1906; and in Column IV the real tariff which could be charged by the Newcastle Power Co., based on their 1907 results and with an estimated diversity factor of 1·66, is set out again for convenience.

Summary.

The present inability of most undertakings to meet a large demand for power at such rates as to hold their own with local plants has been discussed.

A power company can compete successfully with any of these other prime-movers if the company supply transformed alternating current, but if the company is constrained to supply direct current, then it is only with smaller plants, *i.e.*, 100 H.P. or less, that it can hold its own.

The author believes he has made out a case for showing that in all the larger power stations where the capital expenditure is reduced to a minimum and the supply is produced on a sufficiently large scale but within a reasonable distributing radius, a sound scale of charges for power can be made which (apart from all the incidental advantages resulting from a supply from an outside source available at any hour of the day or night) can hold its own with any independent local power plant, whether supplied from steam, oil, or gas. But, as has been known for a long time now, the capital expenditure must be minimised and distribution must not be attempted over too great a radius.

It has been shown that the London companies and municipalities, having been the pioneers of supply, are unfortunately crippled by a large expenditure, and cannot conceivably—except in a few isolated cases—so reduce their cost per kilowatt or increase their production as economically to meet this demand for low-priced power.

This problem in London can only be dealt with by centralisation, and all further expenditure on existing individual systems is prolonging an evil which must ultimately be reflected upon the undertakers, and is, in fact, already so doing.

In the provinces a different problem is presented. Many of the smaller boroughs cannot hope to attain such dimensions, and many of them are already saddled with a high capital expenditure per kilowatt, such as to prevent them from offering the low scale needed. In a small industrial town where the power supply may become the dominating output, all extensions of the local generating plant should be stopped, and that supply should be taken from a power company; or a joint board of local towns could co-operate at a

very considerable saving to the respective partners if sufficiently proximate to one another.

For small local boroughs to go on adding to capital cost, and therefore increasing their difficulties, is to the author's mind a grave mistake. It is of no use arguing that the small gas undertakings paid their way and have now become successful, even on a small scale. The conditions are utterly different, for the gasworks had an open field.

The London discussion on Mr. Snell's paper was opened by MR. J. H RIDER, who, referring to the high capital expenditure of many installations and its effect on price, said he agreed with the author that frequently a poor load factor was improved by supplying power units at a low price, the private and public lighting being charged high in order to equalise matters. The only true basis of charging was the load factor tempered by the diversity factor, and it was possible to arrange satisfactory charges for all kinds of loads, based on the maximum demand system. There was a diversity factor of 1·25 among the L.C.C. tramway sub-stations, so that if you could get private and street lighting and power loads you might even improve on the 1·66 diversity factor given by the author. He agreed with the author's figures as to static and rotary sub-station costs, but pointed out that in Table XIV the L.C.C. charges in Section I were for bulk supply, and in Section II for private uses. He argued that it was wrong to perpetuate the existing London stations if cheap power supply was to be given.

MR. A. M. TAYLOR said the author totally ignored the question of the supply to all consumers smaller than 100 H.P. He considered nothing smaller, as a D.C. sub-station, than 250 KW. Someone had to bear the cost of delivering power to small users who were already equipped with D C. motors and for whom the D.C. L.T. network had already been laid down, even if the L C.C. supplied the energy to the existing authority. Again, the author compared the average charges made by certain London companies to all sorts of small consumers with the costs at which the L.C.C. would deliver power to consumers large enough to pay for the cost of bringing E.H.T. on to their premises. He should have added to these latter costs those of distributing from sub-centres at low tension, amounting to, at the very minimum, £20 per KW. of M.D.—more often £40 per KW. Four years ago the author advocated accumulator sub-stations, but he now passed them by with a casual remark. It was possible to put in cells to give 6 KW. output, on a 2½-hour basis, on 1 sq. yd. of floor space; or, if in two tiers, 12 KW. per sq. yd. The capital costs could be got down to £10 per KW. output on a 2½-hour, or £5 per KW. on a 1-hour basis. Some figures given for Manchester were worked out on the basis of ·39d. per unit plus £8·46 per KW. of M D. (at the station), but he considered that ·20d. per unit plus £9·98 per KW. was much nearer the mark. This assumed that only the "true" running cost was taken in the ·20d., and that all wages were debited to standing charges, which latter was Mr. Snell's own basis. This would give ·54d. per unit for 80 per cent. load factor instead of ·69d. But to compare with his L.C.C. figures they must deduct quite £3 per KW. for distributing expenses from sub-centres, giving 1·15d. and ·44d. per unit for 20 per cent. and 80 per cent. load factors respectively, as against his figures of 1·55d. and 0·69d., a very material difference. The author appeared to have confused the average consumers' load factor and the individual consumers' load factors; in either case it was obviously incorrect to assume a uniform diversity factor. Table XII contained the fundamental heresy of dividing the charge per unit (on account of fixed charges), as obtained at the station, by the diversity factor. The equation for the standing charge in the left-hand column for, say, 80 per cent. load factor, was:—

$$A = \frac{£7{\cdot}6 \times 240}{1 \text{ KW.} \times 8{,}760 \times \frac{80}{100}} = {\cdot}26\text{d. per unit,}$$

while for the right-hand column it was—

$$B = \frac{£4{\cdot}58 \times 240}{1 \text{ KW.} \times 8{,}760 \times \frac{80}{100}} = {\cdot}15\text{d. per unit.}$$

giving respectively (when added to the ·24d. running cost) the author's figures of ·50d. and ·39d. per unit.

Both columns of Table XII purported to be costs for the *same* station load factor, and the right-hand column of Table XII was of no value whatever and should not appear in Table XIV. Mr. Snell's estimate of "Correct charges" for load in stations was probably vitiated by the same mistake. As an example, the published, figures for Poplar for 1906-7 were:—Station load factor, 24·2 per cent.; average consumers' load factor, 7·95 per cent.; kilowatts connected, 6,037; kilowatts demanded at station, 1,980; diversity factor, 3·05; total cost, £30,800; fixed charges, £20,950; running charges, £9,850.

$$\text{Standing charge (as at station)} = \frac{£20{,}950}{1{,}980 \text{ KW.}} = £10{\cdot}6 \text{ per KW.}$$

$$\text{Standing charge (as at consumer)} = \frac{£20{,}950}{6{,}037 \text{ KW.}} = £3{\cdot}47 \text{ per KW.}$$

$$\text{Running charge (as wages)} = {\cdot}56\text{d per unit.}$$

$$A = \text{Cost per unit (as at station)} = \frac{£10{\cdot}6 \times 240}{1 \text{ KW.} \times 8{,}760 \times \frac{24{\cdot}2}{100}} = 1\ 2\text{d. per unit.}$$

$$B = \text{Cost per unit (as at consumer)} = \frac{£3{\cdot}47 \times 240}{1 \text{ KW.} \times 8{,}760 \times \frac{7{\cdot}95}{100}} = 1{\cdot}2\text{d. per unit.}$$

According to Mr. Snell, the second equation should have been—

$$B = \frac{£3{\cdot}47 \times 240}{1 \text{ KW.} \times 8{,}760 \times \frac{24{\cdot}2}{100}} = 4\text{d. per unit.}$$

so that the "true cost" to the consumer should (according to Mr. Snell) be 4d. + ·56d. = ·96d., instead of 1·2d. + ·56d. = 1·76d., the *actual* charge *made* to the consumer.

It would be interesting to know whether the L.C.C. prices in Table XIV were compiled on this basis, as he thought there was a serious blunder on this point.

MR. A. H. SEABROOK commented on the low costs given in Table I, which, if correct, did not leave any margin for the power company's price. He doubted the accuracy of the author's costs for equipments, &c., and remarked that the West Ham sub-station capital costs were about half those given in the paper. He did not agree that the large power station would meet the case, especially in London, where the local stations had small distribution areas and large outputs, nor with the suggested unsuccessful result of unduly increasing the power output at low rates of charge.

MR. J. A. JECKELL doubted the accuracy of the author's figures. He considered that a Corporation "power" plant should only be debited with its own capital charges—as it would be impossible if saddled with the capital charges on the older lighting installations to grant feasible rates of charging. He agreed that the static sub-station capital costs given by the author were excessive.

MR. W. H. PATCHELL supported the idea of the large central power station. He criticised Table I, pointing out that costs "up to 100 H.P." could not possibly be correct, and that "equivalent hours" was obviously misleading, as the size of the load and its duration would affect the figures. He thought that figures relating to paper mills were apt to be misleading, owing to the amount of steam used for boiling, and pointed out the comparatively small power demand of many industries, instancing the following units per H.P. per week:—For a wagon shop, 17; brewery, 28; and a colliery, 36 units. On the other hand, an 85 H.P. motor-driven fan averaged a consumption of 580 units per H.P. per week. Some interesting data on this subject was given in a paper before the National Electric Light Association, New York, in June, 1905.

At the resumed discussion on January 16th, MR. C. P. SPARKS criticised Tables I and II, which appeared to show that a small plant could produce at a cheaper rate than a bulk undertaking; he considered that the figures given could not represent average conditions otherwise the public supply was on a false basis. He agreed with the author's remarks on jute mill driving, and concurred in the estimated equivalent cost, ·48d. per unit, for driving such works, obtained with the steam drive. On the other hand, with the electrical drive there were additional advantages in the way of steady drive, increased output, &c. He also agreed with the author that in the case of really large colliery undertakings, it was almost impossible to supply from outside sources, if they had modern plants of their own. As regards Table III, he could not see the value of giving the units used per head, it should be units per H.P., and the author's contention that improved lamps and their reduced energy consumption would lead to a fall in the proportion of lighting units, he entirely disagreed with, believing that the more efficient lamp would lead to increased energy consumption by the private consumer.

MR. ROBERT HAMMOND said the paper emphasised the importance of the diversity factor—it represented a reduction in the price allowable to the consumer, and it followed that the big station, with its diverse supply, represented a saving to the consumer. He disagreed with the costs shown in Table II, remarking that in Leeds large power users taking into millions of units were charged not less than 1d. per unit.

MR. E. W. COWAN discussed the question of differential rates of charge as between lighting and power consumers, and the utilisation of and return on the capital invested. He considered that the true test was to compare the combined return from lighting and power, which should represent a better percentage on the capital than the return from one department only. It was a fair method of charging to vary the price according to the intensity of demand.

MR G. L ADDENBROOKE questioned the basis of Tables I and II. He pointed out that Parliamentary charges increased capital and handicapped a power undertaking at the start. A 3,000-KW. power plant in an industrial area could supply at ·8d. per unit, but if the plant were increased to 60,000 KW.—which he regarded as appropriate for a large area—then the cost would be halved.

MR. C. H. WORDINGHAM considered that the subject could not be discussed in exact figures; also that too much emphasis had been laid on the diversity factor, which was present in a small works. Load factor was the principal thing to be considered. In the case of London it was necessary to take into account the money already sunk in electricity supply work in considering the power question.

MR. W. H. BOOTH, discussing supply to cotton mills, &c., said that on average Oldham mill taking 1,000 H P. to drive it, also required 12 to 14 tons of coal per week for heating alone, nearly all the year round. The Acme (electrically driven) Mill was heated from a neighbouring factory, and it was a moot point who was losing by the electrical driving, the power company or the mill owners. He understood that the Manchester authorities were going to supply some 2,000 H.P. to a firm at less than ½d. per unit, and this did not appear possible from the author's paper.

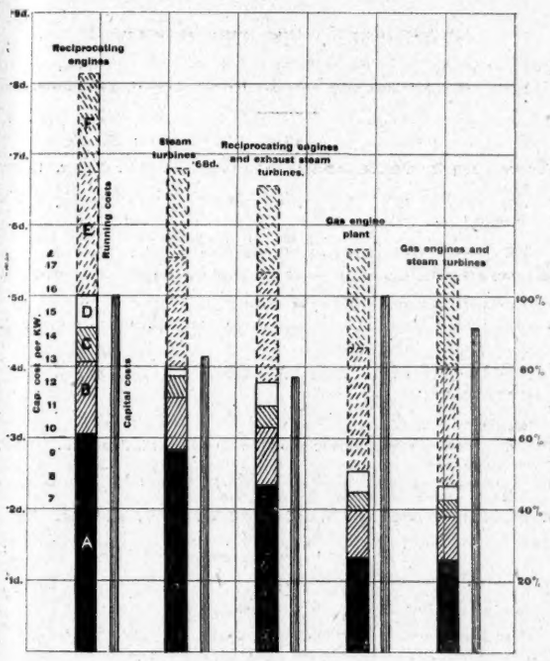
MR. G. W. PARTRIDGE did not believe that there would be a better diversity factor than 1·25, and if this were so, many of the author's figures would be wrong. He further considered £12 per KW. for transmission too low—taking into account that it was necessary to lay the mains to the consumer's door before he would consider the matter of supply. Possibly allowing for the expense of road work in London, the £12 might be £30 per KW., which was borne out by the Newcastle Co.'s figure of £26 per KW.

MR. C. H. CORRINGHAM remarked that the metallic filament lamp with low-priced energy would greatly stimulate the supply. At a station he knew the diversity factor was 2·7; also, at Bermondsey there was space to add 4,000 KW. of plant at, say, £10 per KW. in the existing

station, and he could not see how it could pay to put down plant at similar cost at Barking to give the same supply.

MR. LEONARD ANDREWS questioned whether it was not possible for the cost of production of a large plant to be reduced to such an extent as to compete with small favourably placed private plants. He referred to a paper on "Power Plant Economics," by Mr. Stott, of the Rapid Transit Co., read before the American Institute of Electrical Engineers in 1906.

Mr. Stott advocated a combined plant, consisting of a cheap plant (not necessarily economical) for the peak load and a most economical plant for the flat part of the load curve. The paper included diagrams showing the relative running and capital costs of five different methods of generating power which he (the speaker) had modified to suit Mr. Snell's estimates. To ascertain the running costs, Mr. Snell's figure of ·68d. for steam-turbine generation had been taken, and ·157 deducted (Mr. Snell's capital



ESTIMATED COSTS OF COMBINED PLANTS.

charge of 6¼ per cent. on plant, mains, &c.). A further deduction of ·125d. (rent, rates, management) left ·4d. for running charges, to which Mr. Stott's estimates had been plotted. The results appeared to show that it would be possible to reduce Mr. Snell's figures by approximately 22 per cent. As a further example, the speaker pointed out that a German power station with the combination of steam turbines and gas engines was supplying H.T. power in bulk to a town 30 miles distant (with overhead transmission) at an average price of ·5d. per unit.

The PRESIDENT remarked that 20 years ago the controversy raged round the type of plant to use, and he did not believe that it was settled yet, in view of the strides made by the internal combustion engine. The progress was such that the power companies would, by the time they were going concerns, be relatively in much the same position as regards capital cost as the present undertakers were now. He upheld the author's Table II of costs, which he knew were being obtained now under guarantee, and it was these that the power company had to contend with. His company sold energy at 1d. per unit for power, not to make a huge profit, but to utilise its plant and capital to the best advantage. He thought that progress recently had been far more to the advantage of the small plant than the large.

MR. J. F. C. SNELL, in replying, said that the much debated figures as to small plants could be obtained, but reminded his critics that certain cost items were omitted, as mentioned. Small power users *were* included in Table XIV, as well as large users. As regards storage battery sub-stations, they were too costly, but otherwise very desirable. The Newcastle figures, which were frequently referred to by speakers, included the cost of a good deal of old plant, and as were high; as regarded his sub-station figures, these had been confirmed by speakers in both London and Glasgow. He was quite certain that it was necessary to have a large central plant in order to obtain cheap supply, and this was more necessary in London owing to the high cost of land. He felt sure that Mr. Seabrook was mistaken in his view of the result of unduly increasing the low-price power units, as compared with the lighting units. The power users had, of course, a higher diversity factor than the lighting consumers. The full text of his reply was, owing to lack of time, left over for communication in writing.

The Electrification of Railways.

AT the Royal Institution on Saturday afternoon last, Dr. Gisbert Kapp delivered the first of two lectures on "The Electrification of Railways."

The lecturer, in introducing his subject, referred to the early days of railway electrification, and traced their course of development. The first electric railway which was successfully run was installed at Berlin in 1879, and was operated on the third-rail system at a pressure of 150 volts. Following this, in 1881, at Lichterfelde, a line was laid down in which the running rails were used as the two conductors, and a pressure of 180 volts was employed. At a later date, at Portrush, in Ireland, a line was installed on which a speed of 12 miles per hour was attained. From that time onward progress has been steady and continuous.

The Professor next made reference to the famous Zossen trials of 1903, which were undertaken for the purpose of studying high-speed electric railway performance, and added that, for main-line work, the general introduction of the three-phase system which was adopted in these experiments was impracticable, owing chiefly to the great head-room necessary for the three conductors. At junctions and in tunnels the practical difficulties of construction were sufficient to prevent its adoption.

It will be well, perhaps, at this point to consider the advantages of electric working. The extra cleanliness and comfort of the system have already been amply demonstrated, but the question of economy is still a matter of considerable uncertainty. The coal supply and the method of transportation are factors which closely affect the latter consideration, and in countries having a limited coal supply or where water-power is largely available the superiority of electricity over steam is now generally admitted. The uniform torque of the electric motor makes it possible to increase the tractive effort from 30 per cent. to 40 per cent. for equal weights of steam and electric locomotives, and, further, the low centre of gravity is an important point when the question of speed is considered.

Much time and labour are also saved in repairing operations and in cleaning.

Perhaps the weakest point in the whole system is the current collector. In many districts snow, ice, or liability to flooding seriously affect this link between the generating station and the train, if a third-rail of the usual type is used. Messrs. Wilgus & Sprague have, however, developed an inverted and protected third-rail which successfully overcomes these difficulties.

In the case of overhead work, the conductors must be so suspended that a minimum of springing is set up, or the line will be damaged by the arcing thus produced.

The support of the overhead conductors is a problem which has necessarily received much attention, and the general trend of modern practice is towards the adoption of some form of catenary suspension. There are three main types of this, viz., angular, single, and double catenary. In the first case the two catenary lines and the conductor itself are arranged in the form of a triangle. In the second case the conductor is suspended directly below a single catenary, while in the last case the conductor is held by short links to an intermediate line. Lateral play is prevented by the provision of cross wires at suitable intervals.

Variation of length, due to temperature change, is, in some cases, counteracted by a block and fall system in each section of the line.

One of the most important parts of an electrically-operated train is the controlling apparatus. In continuous-current working either the series-parallel or the multiple-unit system is adopted. In the latter the input into each motor is simultaneously regulated from a master controller.

The distribution of tractive effort, owing to the motors being placed on a number of the cars in each train, which this method renders possible, allows of accelerations as great as 3 ft. per sec. per sec. In short-distance suburban traffic with frequent stoppages this is a most important factor.

For main lines, said the lecturer, high-tension alternating current is the only possible system, and with it speed regulation becomes somewhat more difficult. To meet the requirements of alternating-current working new types of control have been introduced.

In one case the motor windings are so arranged that half the number of poles may be cut out, and thus, for any given frequency, the speed will be doubled. A cascade system of speed regulation has also been largely developed by Messrs. Ganz & Co. In one type of locomotive four motors are used, two being wound for 3,000 and two for 300 volts. When these are connected in cascade a speed of 20 miles per hour is attained, and when running at the full speed of 40 miles per hour the low-voltage motors are cut out of circuit.

In a later type of locomotive, built by the same company, two motors (one having 8 poles and the other 12 poles) are used instead of four, but both must, in this case, be wound for the full voltage. By connecting them first in cascade, and then independently, three speeds are possible. The speeds are in the ratio of the numbers of poles in each motor and of their sum. The ratio will be, in the above case, therefore, 8, 12 and 20.

In conclusion, Prof. Kapp referred to the work already accomplished in Italy, Switzerland and Sweden.

Italy has realised the advantages of electrification, and in her case her policy is a sound one, as the coal supply is limited and, in many parts, the difficulties of transportation are considerable. Large sums have been voted by the Government for electrification purposes. A three-phase system has been adopted, and is being rapidly extended.

Switzerland suffers from even greater disadvantages in regard to the coal supply than obtain in Italy, for the difficulty of transportation is greater. On the other hand, however, sources of water power are good, and already many of these have been appropriated by private enterprise. A Commission was appointed by the Government to ascertain what the power requirements for complete railway electrification would be, and also to advise as to what sources of water power were still available, and suitable for the purpose of generating the necessary energy. After allowing for the heating of the trains at the rate of 1,100 watt-hours per day per passenger seat, and an efficiency of 40 per cent. from the power house to the drawbar, a total of 500,000 H.P. was arrived at.

In Sweden much electrical work has already been done. In 1904 £23,500 was set apart by the Government for experimental work, and since 1905 trials of various types of motors, and of other electrical equipment, have been in progress.

Mr. Robert Dahlander has been in charge of this work, and some definite steps have been taken. A scheme for the electrification of the southern railway system has been developed, and includes the erection of five power houses of 10,000 H.P. each, and of 37 substations for distribution purposes.

Notwithstanding the low density of population, it is estimated that the traffic will show an increase of 60 per cent.

[The second lecture on the above subject by Prof. Kapp will be delivered at the Royal Institution to-morrow, Saturday, 25th inst., at 3 p.m.]

NEW PATENTS APPLIED FOR, 1908.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

634A/07. "Improvements in and relating to electric switches." BRITISH THOMSON-HOUSTON Co., LTD., and E. B. WEDMORE. January 9th. (Date applied for under Rule 18, January 9th, 1907.)

804. "Improvements relating to the production of high-frequency oscillations." H. E. FRY. January 6th.

808. "Seal lock for electric incandescent lamps and the like." E. EGLINGTON. January 6th.

812. "Automatic polarised reversing switch for electro-motors." G. WINTERINGHAM and J. A. COLE. January 6th.

824. "Improvements in electrically-heated hot water bottles." H. W. CHRISTIAN. (Date applied for under Sec. 91 of the Act, January 8th, 1907, being date of application in United States.) January 6th. (Complete.)

825. "Improvements in or relating to induction ignition coils." R. W. SANDERS and M. GREENBERG. January 6th. (Complete.)

827. "Improvements in or relating to electric speed indicators." E. L. A. LERTOURNE. (Date applied for under Sec. 91 of the Act, January 9th, 1907, being date of application in France.) January 6th. (Complete.)

828. "Improvements in and connected with electric motors." E. L. A. LERTOURNE. (Date applied for under Sec. 91 of the Act, January 10th, 1907, being date of application in France.) January 6th. (Complete.)

833. "Improvements in and connected with electric accumulators." C. P. ELIESON. January 6th.

845. "Improvements in or relating to electrical distribution." A. J. BOULT (J. L. Woodridge, U.S.). January 6th. (Complete.)

846. "Improvements in or relating to electrical distribution." A. J. BOULT. (J. L. Woodbridge, U.S.). January 6th. (Complete.)

872. "Improvements in composite telegraph-telephone circuits." C. M. JACOBS. January 7th.

873. "Improved multi-conductor cable." A. WHALLEY. January 7th.

899. "Improvements in telegraphic switches and repeating apparatus and circuits in connection therewith." W. LEIVESLEY. January 7th. (Complete.)

401. "Electrolytes for alkaline storage batteries." T. A. EDISON. (Date applied for under Sec. 91 of the Act, May 10th, 1907, being date of application in U.S.). January 7th. (Complete.)

425. "Improvements in telegraphone apparatus." E. A. HYTTEN. January 7th. (Complete.)

434. "Improvements in electric measuring instruments." BRITISH THOMSON-HOUSTON Co., LTD. (General Electric Co., United States.) January 7th.

440. "Improvements in the manufacture of incandescent electric lamps." EDISON & SWAN UNITED ELECTRIC LIGHT Co., LTD., and E. A. GIMMINGHAM. January 8th.

445. "Improvements in or relating to electrical storage batteries." A. W. SOMERS and R. J. CROWLEY. January 8th.

461. "Improvements in connection with incandescence electric lamps." C. H. STEARN and C. F. TOPHAM. January 8th.

464. "Improved apparatus for wireless or transmission by wires of photographs and the like." F. VON MADALER. January 8th.

468. "Improvements in or relating to electrical meters." SIEMENS BROS. DYNAMO WORKS, LTD. (Siemens-Schuckertwerke G.m.b.H., Germany.) January 8th. (Complete.)

479. "Improvements in and relating to electric switches." F. H. SMITH. January 8th.

484. "Improvements in electrical measuring instruments." O. D. LUCAS. January 8th.

496. "Improvements relating to multiple and harmonic telegraphy with undamped oscillations." S. EISENSTEIN. January 8th. (Complete.)

505. "Improved electric alarm apparatus." W. BLUT. January 8th.

549. "Improved electrical heating apparatus." W. E. TRUMPLER. (Date applied for under Section 91 of the Act, February 1st, 1907, being date of application in Switzerland.) January 9th. (Complete.)

559. "Improvements in electric lamps for miners' helmets and the like." J. H. DRAGER and A. B. DRAGER. January 9th. (Complete.)

560. "Improvements relating to radio-telegraphy." THE AMALGAMATED RADIO-TELEGRAPH Co., LTD. (V. Poulsen, Denmark.) January 9th. (Complete.)

577. "Improvements in electric-driven vehicles." P. KOPP. January 10th.

578. "Improved electrical alarm for safes and strong rooms." T. A. S. MUNFORD. January 10th.

606. "Improvements in electric motors and generators." J. LECOCHE. January 10th.

608. "Improvements in electric switch and fuse boxes or cases." W. E. GARFORTH and G. W. BOUSFIELD. January 10th.

613. "Improvements in fluid contacts for electrical purposes." J. O. GIRDLESTONE and J. W. JONES. January 10th.

620. "Improvements in lamp clusters." W. FAIRWEATHER. (Benjamin Electric Manufacturing Co., United States.) January 10th. (Complete.)

658. "Improvements in or relating to pictorial telegraphy." THE AMALGAMATED RADIO-TELEGRAPH Co., LTD., and N. MASKELYNE. January 10th.

660. "Improvements in multiple-rate electricity meters." ALLGEMEINE ELEKTRICITATS-GES. (Date applied for under Sec. 91 of the Act, January 11th, 1907, being date of application in Germany.) January 10th. (Complete.)

661. "Improvements in and relating to dynamo-electric machine." E. F. W. ALEXANDERSON. (Date applied for under Sec. 91 of the Act, January 12th, 1907, being date of application in United States.) January 10th. (Complete.)

665. "New material for the purpose of separating or enclosing plates of secondary batteries." A. P. STROHMENGER. January 11th. (Complete.)

700. "Improvements in or relating to electric type-printing apparatus." G. A. M. AGRELL. (Date applied for under Patents Act, 1901, January 12th, 1906, being date of application in Sweden.) January 11th. (Complete.)

726. "Electro-chemical process for the manufacture of acetates and in particular acetate of soda." C. H. JACOB. January 11th.

782. "Improvements in and relating to incandescent electric lamps." BRITISH THOMSON-HOUSTON Co., LTD., and H. H. NEEDHAM. January 11th.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., and at Liverpool; price, post free, 9d. (in stamps).

1906.

EARTHING AND PROTECTING ELECTRIC CONDUCTORS. P. G. B. Collyer. 22,500. October 11th.

ELECTRIC ARC LAMPS. British Thomson-Houston Co. and W. H. Dalton. 23,009. October 17th.

TRUCKS FOR ELECTRICALLY-PROPELLED VEHICLES. British Thomson-Houston Co. (General Electric Co., United States.) 26,056. November 17th.

METHOD OF CONTROLLING DYNAMO-ELECTRIC MACHINES AND APPARATUS THEREFOR. C. E. Bonine. 28,503. December 13th. (Date applied for under International Convention, February 17th, 1906.)

LID BOLT FOR STORAGE BATTERY BOXES AND THE LIKE. Chloride Electrical Storage Co. and B. Heap. 28,579. December 14th.

ELECTRIC TREADLES OR RAIL DEFLECTION CONTACT MAKERS FOR RAILWAY SIGNALLING AND THE LIKE. T. E. Haywood and McKenzie & Holland, Ltd. 28,830. December 18th.

ELECTRIC INDUCTION FURNACES. Gründal Kjellin Co. and J. Härden. 29,019. December 19th.

ELECTRICALLY-OPERATED RAILWAY AND LIKE SIGNALS. H. G. Brown. 29,072. December 20th.

ELECTRIC HEATERS FOR FLUIDS. British Thomson-Houston Co. (General Electric Co., United States.) 29,120. December 21st.

ELECTRO-DEPOSITION OF IRON. S. O. Cowper-Coles. 29,300. December 22nd.

1907.

PROTECTIVE DEVICES FOR ELECTRIC TRANSMISSION SYSTEMS. British Thomson Houston Co. (General Electric Co., United States.) 97. January 1st.

TREATMENT OF REFRACTORY MATERIALS BY ELECTRICITY. British Thomson-Houston Co. (General Electric Co., United States.) 1,197A. January 10th. (Date applied for under Rule 5, Patents Rules 1905, January 16th, 1907.)

INSULATION OF DYNAMO ARMATURES. Electric Ignition Co. and P. H. Hall. 1,348. January 18th.

PARTY-LINE TELEPHONE SYSTEMS AND APPARATUS THEREFOR. H. H. Lake. (Kellogg Switchboard Supply Co.) 1,587. January 21st.

ELECTRIC STEAM RADIATOR FOR HEATING BUILDINGS OR THE LIKE. C. G. Nobbs and C. G. Nobbs, Jun. 3,078. February 7th.

COUNTING TRAINS FOR ELECTRICITY METERS AND THE LIKE. G. Hookham and A. I. Sprague. 3,214. February 8th.

ELECTRIC DISTRIBUTORS FOR USE IN INTERNAL-COMBUSTION ENGINES. A. D. Barnett. 3,278. February 9th.

APPARATUS FOR UNDERGROUND AND OTHER HAULAGE. W. Hardman. 3,555. February 13th.

RECEIVERS FOR WIRELESS AND OTHER TELEGRAPHY. L. W. Austin. 4,398. February 21st.

RECEIVERS FOR WIRELESS SIGNALLING. V. Poulsen. 4,801. February 27th.

MAGNETO-ELECTRIC GENERATORS. Albion Motor Car Co. and T. B. Murray. 5,155. March 4th.

INSULATING MATERIAL AND PROCESSES FOR MAKING THE SAME. British Thomson-Houston Co. (General Electric Co., United States.) 5,574. March 7th.

ELECTRIC MEASURING AND RECORDING INSTRUMENTS OF THE THERMAL TYPE. C. E. Foster. 5,904. March 12th.

CONDUITS FOR ELECTRICAL CABLES AND WIRES. W. G. T. Goodman and R. L. Ackland. 7,800. April 3rd.

ELECTROLYTIC ELECTRICITY METERS. B. North and R. Pohl. 9,463. April 28th.

COMMUTATION OF DYNAMO-ELECTRIC MACHINES. Ateliers Thomson-Houston. (Anciens Etablissements Postel-Vinay.) 10,369. May 3rd. (Date applied for under International Convention, May 10th, 1906.)

LIGHTNING ARRESTERS. W. Gifford and E. M. Dixon. 11,163. May 13th.

CONTACT OR COMMUTATOR FOR DYNAMO-ELECTRIC MACHINES. H. R. Rivers-Moore and J. M. Donald. 12,860. June 4th.

BRUSH-HOLDERS AND CARRIERS FOR ELECTRIC GENERATORS AND MOTORS. A. E. Woodhouse. 13,021. June 5th.

BRUSH-HOLDERS FOR DYNAMOS AND MOTORS. H. N. Hickley. 13,259. June 7th.

ELECTRIC INCANDESCENCE LAMPS WITH METAL FILAMENTS. H. Kuzel. 15,017. June 29th.

ELECTRICAL RAILWAY SYSTEMS. L. Beecher. 15,769. July 9th.

APPARATUS FOR ELECTRO-PLATING. S. O. Cowper-Coles. 16,098. July 12th.

ANODE FOR ELECTROLYSIS. R. H. F. Finlay. 17,492. July 31st.

ELECTRICAL SWITCHES. A. P. Lundberg, G. C. Lundberg and R. A. Lundberg. 18,020. August 8th.

CARBON ELECTRODES. J. T. Szek. 18,082. August 9th.

MANUFACTURE OF STEEL AND ELECTRO-METALLURGICAL INDUCTION FURNACES FOR USE THEREIN. A. Biewend. 18,398. August 14th. (Date applied for under International Convention, August 14th, 1906.)

ELECTRIC SWITCHES. O. Kjellberg. 22,612. October 14th. (Date applied for under International Convention, November 1st, 1906.)